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Forthcoming Events.

NOVEMBER 7.

Institution of Aeronautical Engineers:—Ordinary meeting in London. "Steel *versus* Lighter Alloys," Paper by Col. N. Belaiew, C.B.

NOVEMBER 11.

Institute of British Foundrymen (Lancashire Branch, Burnley Section):—Ordinary meeting at Burnley. "Eyesight and Insight," Paper by W. H. Poole.

NOVEMBER 13.

Institute of Metals (London Local Section):—Ordinary meeting in London. "Oxidation, with special reference to Thin Films," Paper by Professor T. Turner, M.Sc.

NOVEMBER 14.

Institute of Metals (Swansea Local Section):—Ordinary meeting at Swansea. "The Inner Structure of Alloys," Paper by W. Rosenhain.

Barrow and District Association of Engineers:—Ordinary meeting at Barrow. "The Determination of Hardness in Metals," Paper by A. H. Hird, B.Sc.

NOVEMBER 15.

Institute of British Foundrymen (Wales and Monmouth Branch):—Ordinary meeting at Cardiff. "The Manufacture of High Tensile Cast Irons," Paper by A. Marks.

Institute of British Foundrymen (Lancashire Branch, Junior Section):—Opening meeting of the New Junior Section. A Lecture on "Foundry Craft," by W. H. Sherburn.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

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Fundamental Research.

One of the best-known foundrymen in Great Britain is carrying on, whenever and wherever possible, a propaganda for the prosecution of what he terms fundamental research. He bases his thesis upon an assumption that the fundamental factor in research is that if a person is in a position to enunciate the full and complete statement of the problems, then 75 to 90 per cent. of the research is completed. It is interesting to see how this works out in practice. Suppose trouble arises in the use of glass-bottle moulds and the user is convinced that the defect is due to excess oxygen. He therefore postulates the question, "What is the influence of oxygen on cast iron." In doing so he assumes that oxygen does exist in cast iron, and invites questions as to whether he means free or combined oxygen and as to the type of cast iron. His question, therefore, is modified to "Can oxygen exist in cast iron of a stated composition, and if so, in what form?" It is obvious, therefore, that the original question would be largely solved if the question of the existence and behaviour of oxygen in cast iron (which would, of course, necessitate a full knowledge of the influence of all normal elements) was known. The fundamental research required is obviously one of the provision of data as to the specific gravity, specific heat, co-efficients of expansion and contraction, and similar characteristics under varying conditions. Candidly, such work is excellent and would solve, when *intelligently* used, the major portions of the problems involved in foundry practice. But, "the full and complete statement of a problem" is beyond the *connaissance* of the major portion of those in charge of foundries now. The present "messy" (a word often used by the foundryman referred to) condition is doing the most valuable work because it is directing the thoughts of the foundry trade in the right channel. In other words, whilst this production of fundamental data is theoretically correct, the instruction of the foundry trade as to the prosecution of research for themselves is of the utmost value, because the application of the results now being obtained involves that the foundries shall be run on better lines. The first work of a research association is to accomplish such work as to render the industry for which they cater in a suitable condition for the reception and application of fundamental data. It is clear that many jobbing foundries at the present time are unable adequately to apply existing fundamental data owing to a lack of suitable apparatus. Sometimes there is not even a weighing machine. Thus if fundamental data shows that a 0.85 per cent. combined carbon content is definitely the best for a certain casting, they have no means of checking the quantity or quality of the raw materials nor the finished products. Thus where one foundry finds that another is making technical progress because of its association with a research organisation, which tends to make it place its own technical house in order, then it is quite likely to follow suit. When this has become national, and the majority of foundries are technically equipped for the adequate application of research data, then the man who insists on the complete devotion of the activities of the B.C.I.R.A. to obtaining fundamental data will have our unstinted support. At the moment, the recently altered policy of the Research Association is adequate and deserves the support of every foundry. We are not too sure that the production of fundamental data is not the work of the National Physical Laboratory, as such results should belong to the nation.

Moulders' Pins.

From time to time some person with an inventive mind turns his attention to the simplest and most elementary article and discovers that the age-old pattern does not always represent finality. Such has been the case with moulders' brads, for one cut brad may weigh as much as eight or twelve wire pins. Wire pins have been placed upon the market by Mr. H. W. Venton, of 32, Queen Victoria Street, London, E.C.4, who has had a long experience as a practical moulder. The pins range in size from about 1 in. to 6 in., and two sizes are reproduced full size in our illustration. The wire pins eliminate the "making up" of the surface of the mould, as is often the case with cut brads, and, being sharp-pointed, they can be inserted at greater speed. Obviously, they can be used in delicate places where the thickness of a cut brad would prevent its use. Used either straight or bent to suit, the wire pin can be used to strengthen very small and weak cores.

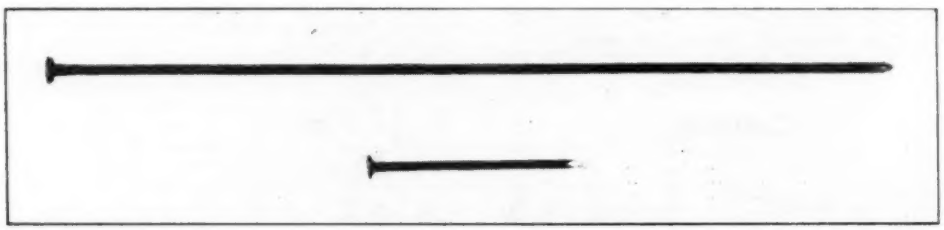


FIG. 1.—A NEW TYPE OF MOULDERS' PINS.

Although they have only been on the market for a short time they have already found much favour with automobile, steel, aluminium, brass and malleable foundries.

Such small items as moulders' pins serve to show the real size of the foundry industry, as a stock of 20 tons is constantly maintained in London, and a further 20 tons at the works ready for immediate despatch.

Life of Liquid Metal.

To-day (Thursday), before the Association Technique de Fonderie, M. Charles Cury read a Paper on "A Search for a Suitable Fluidity Test" (La Mise au Point de l'Eprouvette de Coulabilité). He pointed out that pyrometers could only be used for low melting point alloys such as light alloys, and some have a copper base. The temperature of a liquid alloy is only one factor amongst many which controls the "life" of an alloy—a property which can be defined as the ease with which it can fill a mould. The lecturer, after having dealt with the different theories, which have been expounded, outlined his own work to develop a sure test of "life," free from outside interference.

He reviewed the results already given before the Ecole Superieur de Fonderie, and added more recent tests which are common to all alloys.

A Correction.

In Mr. Hurst's article on "The Influence of Sulphur on Cast Iron," the illustration Fig. 2 has been displaced in relation to the arrow signs, indicating the outside and inside edges respectively. The sulphide segregations are naturally on the inner edge of the casting.

To Visit India.

Mr. F. E. McGrah, a director of Wm. Cummings & Company, Limited, the well-known foundry-facing manufacturers, is sailing from London to Bombay on November 28. He expects to be away from England for about four or five months. He is visiting Calcutta, Rangoon, Singapore and Colombo.

Foundry Queries.

Phosphor Bronze.

Could you advise the best method of making phosphor bronze bars, as my results have not turned out satisfactorily? At present the two mixtures I have used are 88 copper, 10 tin, and 2 phosphor bronze, made from 73 lbs. of copper, 10 lbs. 10 ozs. tin, and 16 lbs. 6 ozs. phosphor copper. I do not cast the metal too hot in my opinion. The chills are hot before casting, and very lightly faced with boiled oil and plumbago. The results from this method are air holes on the face of the stick and also the stick comes out a very light colour instead of dark.—A. J. C.

Surface of Iron Castings.

We should be glad if you could give us some information on the following matter:—

Iron Castings.—We have had considerable trouble with the appearance of castings. The surface of the castings is mottled, not smooth, and is due, we think, to sand fusing. Can you give us any advice as to how to get over this difficulty, or suggest a sand which will not fuse?—A. & R., Ltd.

[You give no details as to the type of sand used, the nature of its preparation or quality and amount of coal dust. On receipt of this we can probably advise you. You might advantageously peruse Mr. List's article on another page dealing with this subject.—ED.]

Two Important Meetings.

The fourth annual meeting of the British Cast Iron Research Association will be held at 3.30 p.m. on November 19, at the Institution of Mechanical Engineers, Storey's Gate, Westminster. The President, Lord Weir, will take the chair.

A meeting of representatives of foundry equipment and supply firms is to be held at 3.30 p.m. on November 13, at the Engineers' Club, Coventry Street, London, W., to discuss the question of Foundry Exhibitions.

Continental Foundry Practice.

Mr. A. S. Beech, who is very familiar with Western European foundry conditions, is to read a Paper before the Falkirk Section of the Scottish Branch on this question on November 15, at the Falkirk Technical Institute, at 6 p.m. He is using both lantern slides and cinematograph films for illustration purposes.

Iron and Steel in Sweden.—The shipments of iron ore from Sweden have greatly increased since the resumption of industrial activity on the Ruhr, and the export figures have begun to approach the normal. The exports of iron and steel are still on a small scale, scarcely more than half the 1913 exports. Also the sales of Swedish iron for home consumption are abnormally small. The usual slackness of business in the summer entailed a reduction of the output in June, but with a slight improvement in the following months. With the exception of open-hearth furnaces, the number of furnaces and hearths at work further diminished in August.

Modern Bell Founding.*

By Wesley Lambert and G. Hall.

SECTION I.—HISTORICAL NOTES ON BELLS.

How the bell originated, or by whom it was actually invented, is lost in antiquity. Josephus tells of bells fixed on the golden roof of Solomon's Temple to "keep the birds from alighting thereon," which bells, presumably, were very small and not much larger than the present-day hand-bell. Suetonius mentions that Augustus caused a bell to be hung before the Temple of Jupiter. It is recorded that Julius Cæsar on landing in Britain heard the tinkling of the bells upon the spear shafts of the assembled warriors. Large bells—such as one is now familiar with—were not known until the early centuries of the Christian era. The introduction of the large bell has been ascribed to Italy, both Bishop Paulinus of Pola, about the year 400, and Pope Sabinianus, about the year 600, being accredited with effecting its introduction. The Venerable Bede brought a bell from Italy to place in the Abbey of Wearmouth in 608, and mention is made of a bell being in use at Whitby Abbey at about the same time. S. Ethelwold, Bishop of Winchester, 923-984, was responsible for the casting of the bells for Abingdon Abbey. Ingulphus, the Chronicler of Croyland Abbey, mentions that a peal of seven bells was hung there in the tenth century, and that "there was not such a harmonious peal in the whole of England"—a statement which implies that "rings of bells" were common at that time. Of early bell-founders, London can claim as citizen, Alwoldus, a "*campanarius*" (bell-founder) as early as 1150, and in the reign of Richard I of England the Guild of Saddlers was granted the privilege of ringing bi-weekly the bells of the Priory of S. Martins-le-Grand; the Priory being entitled to claim the sum of 8d. for "ringing" at the funeral of deceased members of the Guild.

An ancient bell having the date 1133 *cast* upon it was recovered from a pond at Preston in 1897. It is stated on good authority that the bell at Fontenville, Bayeux, in France, bearing the date 1202, has the distinction of having been in continuous use for the greatest number of years. In England, what is believed to be the earliest church bell is to be found in St. Chad's Church, Claughton in Lonsdale, Lancaster; it bears the date 1296, and although a small bell, it has done duty for over 600 years. Bells of large size were founded as early as the twelfth century, about which period a tenor bell was added to the "ring" at Canterbury Cathedral; the complete "ring of bells" requiring thirty-two men as ringers. This bell was, however surpassed by one cast in 1316 which weighed 3½ tons. John of York was a noted bell-founder about the middle of the 14th century; at Sproston in Leicestershire there is a bell inscribed (in Latin) "John of York made me in honour of the Blessed Mary."

The following list includes the best known English bells:—

Name.	Place.	Weight. Tons.
Great Paul	St. Paul's Cathedral	16–17
Big Ben	Westminster	13–14
Great Peter	York Minster	12–13
Great John of Beverley	Beverley Minster	7–8
Great Peter	Exeter Cathedral	6–7
Great Tom	Oxford	6–8
Great Tom	Lincoln Cathedral	4–5

Westminster Town Hall, London, possessed a bell famous for its connection with a story told as happening in the reign of William III of a sentinel at Windsor Castle, who was accused of sleeping at his post. He defended himself by stating that he was not asleep, but that he was placing his ear to the ground in order to hear the Westminster clock strike at midnight, and that he not only heard it, but that it struck 13 instead of 12. It was subsequently attested that the clock did, on that occasion, actually strike 13, and the soldier was acquitted.

The bell of Lincoln's Inn Chapel, London, formed part of the spoils at the capture of the City of Cadiz by Lord Effingham, of "Good Queen Bess days," and was brought to England by the Earl of Essex, favourite of that Queen, in 1596. Notwithstanding the general discontinuance of the ringing of the Curfew at the end of the 16th century, the bell at Lincoln's Inn Chapel continued to be rung and the custom is still maintained, the Curfew being rung nightly at 9 p.m. The bell is tolled 50 times, a pause being observed after the first and before the last strokes.

The great Westminster clock-bell "Big Ben" was so named after Sir Benjamin Hall, who was in office as the Parliamentary First Commissioner of Works at the time the bell was cast. The original bell was made by Messrs. Warner, of Stockton-on-Tees, but it developed a crack during its public exhibition at the foot of the clock tower, and the bell was recast by Messrs. Mears, of Whitechapel, London; it weighs 13½ tons.

The known largest bell in existence is the great bell of the Kremlin, "The Monarch of Moscow." The value of the metal used in the casting alone was said to exceed £66,000 sterling; the casting is now defective, a considerable piece having been broken away from the side owing to a fall in 1737. The table (Table I) below is a comparison of the estimated weights of the heaviest bells of which records are available.

When large bells were required in the early days they were cast locally ready to be placed in the belfry or bell-tower. The bells of York Minster were moulded and cast within the Minster walls; one reason, and the principal reason for so doing, was the absence in those days of good country roads, and the difficulty of road transport of very heavy bells was therefore practically insurmountable.

Bell founding was for centuries a very slow process. The appliances for "striking-up" and lifting the mould, and also the furnaces for melting the metal, were all very crude. The old-time bell-founder, however, was an expert craftsman among his fellow-men, and, speaking generally, the craft was handed down from father to son.

TABLE I.—*Weights of Largest Bells.*

Place	Tons.	Diameter. ft.	ins.
Moscow	220	22	8
Trotzkoi-Russia	171		
Moscow	110	18	0
Mandahay-Burmah	87	18	0
Moscow-S. Ivan's Ch.	57	18	0
Pekin	53	14	6
Novgorod	31		
Moscow	28½		
Cologne Cathedral	25½	11	3
Nanking	22		
Lisbon Cathedral	21		
Kioto-Japan	20	10	0
Paris (Montmartre)	18¼	9	11½
Vienna	17¾		
London (Great Paul)	16¼	9	6
Rouen	16		

NOTE—Authorities differ considerably in the weights of some of the bells included in the list.

"Robert Alton made me 1663." Robert Alton, upon receiving an order to make a bell or a peal of bells for a certain church would proceed to erect his temporary foundry near the church itself. He would commence actual operations in the foundry by building up a core for the mould in a hole dug in the ground. The base-plate was either of timber or of iron; the core-spindle being mounted in a socket set in the centre of the base-plate. Having built the core with bricks and clay by the aid of a strickle, the core was dried by a charcoal fire. A second strickle was then placed into position and a thickness of sand or loam struck on the core, conforming to the finished shape of the outside of the bell to be cast; any inscription being formed in wax and carefully

* This Paper is one of a series of foundry problems being exchanged between the Institute of British Foundrymen and the American Foundrymen's Association. Initiated in 1921 with the first A.F.A. Paper before the I.B.F., this is the third annual exchange Paper presented by the British organisation. Both authors are members of the London Branch of the Institute of British Foundrymen.

fastened to the sand or loam, which wax in the drying process melted away, leaving the imprint of the letters in the cope or outer case of the mould. The outer case of the mould was in its turn subjected to the process of drying. The cope was formed of brickwork and loam by building it on a large iron ring until the core and bell-thickness was completely enveloped. After a period of drying this outer part was lifted, then thoroughly dried and finally washed with a charcoal-and-clay wash to give it the requisite smooth surface. The bell-thickness was then removed from the core, and when the complete mould was re-assembled a space was left between the cope and the core, of a shape and thickness corresponding to that of the bell required. The cope or outer case having been put back into position, the complete mould was rammed tightly in the earth, and, maybe, wedged in with timber to support any strain set up in the casting operation. Simultaneously with the moulding operations a furnace had to be erected. The furnace of Robert Alton's day was on much the same lines as the reverberatory furnace of to-day, but on account of its temporary character somewhat more crudely built than the furnaces to be found in modern bell foundries. Charcoal was the fuel used for melting the bell-metal. A hole at the side of the furnace served as a tapping-hole, communication being made between the furnace and the mould by a sloping channel. Great care must have been exercised in respect of both the metal and the temperature of casting. Many old bells cast as long ago as the 15th and 16th century are made of much better metal than some of the bells cast within the last few decades. The old bell-founders, therefore, had much to their credit as skilled craftsmen, and considering the difficulties to be surmounted in the exercise of their craft, they must have been men of strong will and courage. Robert Alton, having cast a bell and allowed it to "cool off," would then proceed to strip it from the mould and to "clean it up a bit" with the object of making as presentable a bell as possible. He would then sound it carefuly in order to observe whether it yielded a correct note, a musician with a violin sometimes being resorted to until the correct note was obtained.

Neither the contour of the bell nor the art of bell-founding has changed, except in minor respect, through many centuries; useful knowledge, however, has been gleaned from the study of the products of the old bell-founders. In early days bells were not "rung up," as they are now, but were simply "chimed"—*i.e.*, sounded as a result of swinging the bell just sufficiently to strike the suspended clapper, or the bell remaining stationary, the clapper being swung; the latter a most deplorable practice, and a custom which accounted for many cracked bells. That this was realised as early as the 16th century is shown by the Churchwarden's accounts of St. Lawrence, Reading, for 1584, in which an entry appears as follows:—

"Whereas there was, through the slouthfulness of the sextun in time past a kind of tolling ye bell by ye clapper rope; ye was now forbidden and taken away."

When "rung up," as is now the practice, the bell swings through a little more than a complete circle, and after each stroke rests in an inverted position, that is, mouth uppermost against a stay, until "the rope" is again pulled, when it swings down, strikes the clapper, and reverts again to an inverted position on the other side.

The inscriptions and markings found on old bells are often quaint and sometimes very peculiar. Occasionally, here and there, a bell of freakish shape has been hung, and such a bell usually possesses a somewhat displeasing tone. There is a superstition that bells shiver and quake on the occasion of a crime or disaster. The bells of Canterbury are said to have rung without human agency what time Archbishop Beckett was murdered, as also did the bells of Lincoln at the burial of St. Hugh, the Lincoln martyr:—

"A' the bells o' Merrie Lincoln
Without men's hands woe rung;
And a' the books o' Merrie Lincoln
Were read without men's tongue;
And ne'er was sich a burial
Sin Adam's days begun."

It is placed on record that high festival was often observed before church bells were hung in the belfry. The casting was used as a receptacle of liquid refreshment for the enjoyment of the assembled parishioners!

York possesses two interesting memorials having reference to the art of bell-founding. The one is an ancient cross erected to the memory of an unknown craftsman. On one side of the cross is a brazier or furnace, and on the other is the figure of an antique bell. The second memorial takes the form of a stained-glass window in the nave of the Minster, and is known as the "Bell-Founders' Window." Several of the operations involved in casting a bell are represented. The mould for the bell is shown in vertical section, and the metal is seen running into the mould. The man (over life size) is teeming the metal from a crucible; an assistant is holding back the dross. The window was presented to York Minster in 1320 by Richard Tunnock, Bailiff of the City.

* * * *

"Lambert made me weake, not fit to ring,
But Bartlet amongst the rest hath made me sing."

(*Inscription on an old bell at Richmond, Surrey.*)

W. L.

SECTION II.—BELL FOUNDING.

Modern practice in the art of founding large bells follows more or less on the lines adopted by the old bell-founders, but whereas in times gone by it was firmly imagined that bell-founding was one of those crafts the mysteries of which were handed down from father to son only, the mysteries have vanished, and the art of bell-founding is one well within the scope of experienced loam moulders, irrespective of parental ancestry. Nevertheless, as is only to be expected, large bells of good tone bearing long cast-on inscriptions and much artistic ornamental work are most often the product of firms specialising in this class of foundry work. Naturally, the modern bell-founder, not having to face any great difficulty regarding the transport of his heavy castings, establishes a well-equipped foundry replete with a suitable range of equipment and accessories to meet the requirements of his various customers. In addition, a designing department, pattern shop, and machine shops are also included in the modern bell-founding works. With the foregoing facilities for output, it is customary, whenever possible, to cast a complete peal of church bells from one and the same cast of metal, use being made of one or more ladles to hold the metal when the furnace or furnaces are tapped. Should the weight of metal to be melted for the complete "ring of bells" exceed the capacity of the furnace, as sometimes happens, the "cast" must be divided, care being taken to ensure that the metal of subsequent casts approximates in composition as closely as possible to that of the previous cast.

Working drawings, together with an estimate of the weight of each bell in the "as-cast" condition, are prepared in the designing department and passed on to the patternmaker. The working drawings are usually made full-size, thus obviating any error in setting out the curves of the bell, these latter being an all-important factor in determining the thickness and subsequent tonal results of the finished bell. The working drawings are often prepared on thin paper, thus enabling the patternmaker, by placing carbon sheets between the timber and the drawing, to trace the lines direct upon the wood by means of a stylus. The timber used by the patternmaker for the strickle-board, etc., must be of hard non-porous character and well-seasoned, otherwise, owing to distortion of the wood, unequal thickness and distorted shapes will be evident in the castings, the rectifying of which defects is not only costly but requires considerable skill on the part of the mechanic whose job it is to prepare the bell for tuning. Two strickle-boards are required for each bell-mould; an outside-board for striking-up the exterior, and an inside-board for striking-up the core. Both boards must have well-finished sharp edges, and notches are cut in each board to indicate the positions at which sizes are determined by the aid of size sticks. These latter are

supplied by the patternmaker, and must be preserved from injury when in use. The strickle-boards and other parts made by the patternmaker are checked by a draughtsman before being passed on to the foundry. In general practice it is now usual for the mould for the heaviest bell—known as the tenor bell—to be commenced in advance of the others, and the subsequent moulds are proceeded with in order of weight of bell to be cast. The reason for this is obvious, as if all the bells are to be cast from one charge of metal, the heavier the bell to be cast the longer the period required to prepare and dry the mould in order to have all ready for filling on the same day.

The actual operation of moulding proceeds on the following lines. Use is made of a heavy base-plate—permanently fixed on a concrete bed on the foundry floor—having three raised sides, which are machined level, upon which stands are placed serving as stools for the "bell-case." In the centre of the baseplate is a conical pin upon which the bottom end of the spindle rests; the top end of the spindle fits over a similar pin which is fixed in a robust cast-iron bracket projecting from the foundry wall or a column. The spindle is made of round steel, and is machined over the entire length. The projecting bracket is mounted on a pivotal pin, and by this means it can be swung away from the mould on the completion of the moulding operations. Attached to the spindle is a bar which serves to carry the strickle-boards; these latter are bolted into the desired position. The striking-up of the mould portion forming the outside of the bell surface differs somewhat from the usual practice followed in ordinary loam moulding, a cast-iron "bell-case" casting, not unlike a bell in shape, being employed in lieu of the usual brickwork and binders. These "cases" are usually about 6 in. larger in internal diameter than the external diameter of the bell to be moulded, thus allowing for a generous thickness of loam, etc., in the mould proper. The "bell-case" castings are provided with trunnions for lifting and upending purposes. These trunnions are essential, as the portion of the bell-mould in question is moulded the reverse way up, that is to say mouth upwards, and it is reversed in the completed mould as assembled for casting.

The "case" is placed on the three stands aforementioned, and carefully squared and lined-up to the appropriate strickle-board which is in position on the arm of the spindle; loam cakes, previously moulded and thoroughly dried, are cemented with a clay wash to the inside of the case, and the first rough coat of loam is plastered on over the whole surface of the cakes, use being made of the strickle-board and the necessary care being taken to leave a sufficient space for a second or final coat. The "case" is then placed in the drying-stove, where it remains until the mould has become thoroughly dried. In like manner all the other mould "cases" for the complete set of bells to be cast are prepared and stoved. The drying-stove equipment usually includes various sizes of trolleys or carriages, and each "case" is placed upon a separate carriage, due regard being paid to the position of each case in the stove, and also economy of floor space, in order to utilise to the best advantage the full stove capacity. As soon as the rough loam coating of a mould is thoroughly dry, the "case" is returned to the base-plate and again levelled and set as accurately as possible to the strickle-board, measurements are checked, and the final coat of loam is applied. The loam used for this final coat must be well ground and of a very fine and smooth texture, fairly free from clay; cowhair is sometimes used in admixture with the loam to ensure the necessary binding. The final coating of loam as applied to the mould must be as thin as practicable, and should rarely exceed three-eighths of an inch in thickness, otherwise contraction cracks will develop in the mould during the final drying, and unsightly "veins" will be found on the surface of the subsequent casting from the mould; such "veins" may seriously detract from the appearance of the lettering and ornamental work with which many bells are embellished. The final coat of loam having been applied to the mould and carefully strickled, the mould in its "bell-case" is returned to the drying-stove and very thoroughly dried, great care being taken that the mould is not scorched or burnt during this operation. The mould is then taken from the stove, and when quite cold is checked for size by an experienced moulder, who, when he has satisfied himself that the mould is correct, proceeds to apply a wash of good blacking to the surface of the loam. A satisfactory blacking-mixture for this purpose is made up by an intimate admixture of 60 per cent. of charcoal-blacking, 30 per cent. of plumbago, and 10 per cent. of china-clay.

After careful sleeking of the surface of the "blacking" to a very smooth finish, the mould is lined and set out to receive any ornaments or inscriptions which have to appear on the bell when cast. As many as five to six hundred letters appear in some of these inscriptions, whilst two hundred are quite common. Each letter or numeral is stamped into the mould separately, this work, including the stamping of the ornaments, being done while the mould face is still soft after the application of the "blacking-wash." The inscription is carefully checked as soon as the whole is completed, and if found to be correct, the mould is dried-off by the heat from a small brazier placed under the mouth of the "bell-case." Fig 1 shows a bell bearing nearly 1,000 letters, besides ornamental work cast on the surface; the letters are 1¼ in. and ¾ in., and stand out in relief about ⅛ in.; more than 2,500 letters appear on the complete set of eight bells.

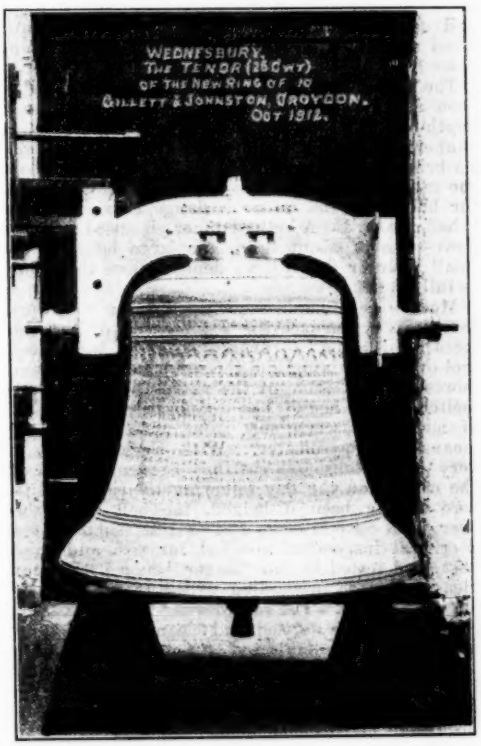


FIG. 1.—BELL WITH NEARLY 1,000 LETTERS CAST ON IT.

Whilst one gang of moulders is preparing the set of "cases" or outer parts of the bell moulds, another gang is preparing the cores or inside parts. The strickle-arm for working-up this part of the mould is similar to that previously described; a circular base-plate is used upon which the core is built, the diameter of the plate corresponding to the diameter of the outer flange of the bell-case. Bolt-holes in each part serve as a means of subsequently securing each part to the other when the complete mould is assembled. The strickle-board of exact shape to that of the desired interior of the finished bell is then fixed into position on the strickle-arm, and the core is built of brick and loam in much the same way as any ordinary loam core of a similar type is commonly constructed. Should, however, the core be intended for the mould of a large bell, a "binder" of cast iron is built into the top of the core. The

same practice is followed as regards the drying and final coat of loam, blacking, etc., on the core, as appertains in preparing the outer portion of the mould as previously described. Special care and attention must be given to the forming of the top of the core for the reason that bells are cast from the top with the mouth of the bell towards the floor, and therefore, unless the top of the core is well made and free from cracks, a scab or a fracture may result, and the subsequent casting may be judged a "waster."

In assembling the completed parts of the mould no setting-out or marking-off is entailed, as is so often the case in loam moulds, provision being made for this in the actual moulding. Both the strickle-board for the outer "case" and for the core have a tapered seating, thus for a large bell the seating would be about 2 in. wide, and the bell-case is carefully lowered by the crane over the core until resting just above the seating, and whilst in this position the suspended part is gently and carefully rubbed by a rotary motion until when the bell-case is finally lowered a perfect joint is secured.

The mould for the largest bell of the set having been assembled and bolted, it may be sunk to a depth of a few feet into the foundry floor; a runner-box is then fitted and bolted into position. To bring the runner-boxes of each mould to about the same level one with another, provision is made for bolting a box on to a flange carried on the "bell-casing." A plug-runner is used with a down-stem of about 2 in. for large bells, and a small riser or "flow" to denote when the mould is full of metal.

Modern bell-founders mostly use the reverberatory type of furnace for the melting of the bell-metal, this type of furnace ensuring better control over the mixing and the subsequent alloy, and, moreover, the whole of the metal required can be melted in one heat. The temperature of the bath of metal is ascertained from time to time by means of a pyrometer. With the exception of very large bells, all castings are removed from the moulds on the day following the cast, and the core having been dislodged, the bell is brushed over with wire-brushes and is then submitted to a critical inspection, checked for size and thickness, and tested by the "tuner" as a preliminary measure before proceeding with any further work on the casting. The bell having passed this first inspection, it is fettled and cleaned up by filing, after which it is subjected to a process of cleaning by sand (or shot) blast. The casting is again inspected, and if found satisfactory the bell is passed on to the machine shop. The second inspection and passing of the casting removes any anxiety the foundryman may have had as to whether the casting was a success or a "waster"; the inspection after sand-blasting serving to discover any casting-defects of a serious character.

In general foundry practice little or no public ceremony attaches to the actual casting operations; this, however, is not always so in the bell-foundry. The occasion upon which a peal of bells is to be cast is often made a ceremonial day, and regarded as an auspicious event. One can well leave to the imagination of the reader the incongruous atmosphere in which some of the visitors who assemble in the foundry find themselves on such an occasion, and also the effect upon the nerves of both the visitors and management, if for any reason the "tapping" of the furnace is delayed long past the appointed time.

G. H.

SECTION III.—METALLURGICAL NOTES ON BELL METAL.

The metal *par excellence* for large bells is essentially an alloy of copper and tin. Large bells have been cast in other metals or alloys, as, for instance, in aluminium-bronze and in steel. Lord Grimthorpe, an eminent authority on clocks and bells, when asked his opinion of some bells cast in steel, replied: "If the object of the bells is to make the greatest noise for the least money, steel bells are very good ones, but the less you ask me to say about the quality of the noise the better." Bell-metal is a true bronze, in that it is compounded from copper and tin, the former metal being present in predominating quantity. The alloy "80 copper 20 tin," passing under the name of bell-metal, is quoted in books of reference more often than any other alloy of these two metals; whereas, it is common knowledge among those persons interested in metal for bell-founding that a fairly large departure from the 80:20 alloy is permissible without sacrificing the strength or tone of a bell. All metals are resonant when struck under favourable conditions; even lead, cast in the form of a hollow spherical segment, is stated to be very sonorous.

The first requisite of a good bell-metal is that it should be pleasingly sonorous when struck, the sound produced being of a full, rich, and pure tone. Other requisites are comparative cheapness and good casting properties. In these respects the alloys of copper and tin, *i.e.*, the true bronzes, possess the before-mentioned qualities in a marked degree, the 80:20 alloy being a good example in a somewhat wide range of these alloys. To ensure a pure full sound from a bell it is not only necessary to employ a suitable alloy and correct proportions for the bell, but the casting itself in the selected metal must be sound, as free as possible from blemishes, slag, and oxide inclusions, and should be representative, in every respect, of the best art of the foundryman.

Nowadays, the foundryman proper has but little say in respect to either the shape or proportions of the bell to be cast, and merely acts upon instructions received from the designer. Nevertheless, he is expected to produce a casting which will result in an almost perfect musical instrument.

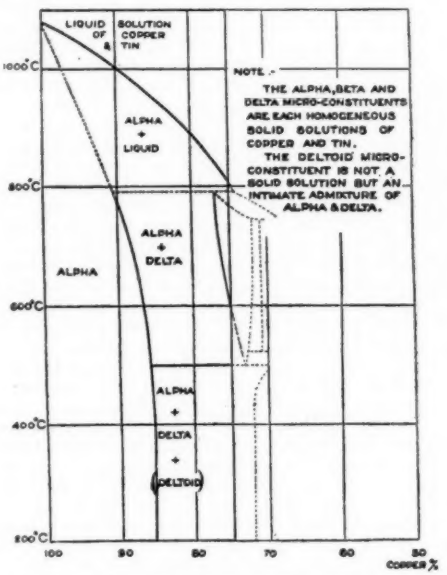


FIG. 2.—THERMAL EQUILIBRIUM DIAGRAM OF COPPER-TIN ALLOYS.

The range of the true bronzes which may be said to constitute the genuine bell-metal alloys suitable for the founding of large bells is represented by the difference between a tin content of 17 per cent. on the one hand and 25 per cent. on the other. Authentic analyses of large bells cast in bygone days give figures well outside the range indicated, but little is known as to the fullness or purity of sound emitted by these bells. Bell-metal containing from 20 to 24 per cent. of tin, with a leaning towards the higher amount, is claimed by some authorities as representing the ideal alloy for large bells, and, this being so, it follows that if the furnace charge is to include an admixture of scrap in the form of old bells, the resulting alloy can only closely approximate the ideal when "mixture by analysis" is resorted to in making out the furnace charge-sheet. The intentional introduction of other metals additional to copper and tin, although favoured by some bell-founders, is of doubtful advantage, and where scrap also is included in the melt, the adoption of the "mixture by analysis" method of calculating the charge is rendered almost imperative if successful and concordant results are desired.

The rich sonorous qualities of the bronze used for large bells such, for instance, as church bells, is said to be due to the characteristic constitution or microstructure of the metal in general use for this class of bell. Fig. 2 represents a portion of the thermal equilibrium diagram of the copper-tin alloys. This diagram in its entirety is of a somewhat complex character, and, for the sake of simplicity, only that portion of the diagram covering the copper-tin alloys having a bearing on the constitution of bell-metal has been included.

Reference to this diagram will show that those alloys containing from little or no tin up to as much as 13 per cent. of this metal, when cast and allowed to cool down very slowly to the ordinary atmospheric temperature, consist wholly of a solution of one metal in the other and are therefore of homogeneous structure; only one micro-constituent is observable under the microscope. The alloys with a tin content of between 13 per cent. and 28 per cent. when cast and very slowly cooled are found to consist of two solid solutions, one richer in tin than the other, and in addition to these two solutions a further constituent is in evidence, this being an intimate admixture of the two before-mentioned solutions, and itself possessing different physical properties from either the first or second solid solution. The first solution is designated the alpha, the second solution is known as the delta; the intimate mixture of the two solutions is known as the deltoid constituent.

So much for the theoretical constitution of the range of alloys now under consideration for bell-

FIG. 3.—PHOTOMICROGRAPH OF BELL METAL.

founding purposes. It is only necessary to point out that in the foregoing explanation of the thermal equilibrium diagram emphasis has been given to very slow cooling of the alloys. Such a procedure as is indicated by the words *very slow cooling* does not appertain in foundry practice. Bell-metal cast under normal conditions and subjected to the usual "cooling out" may be regarded as constitutionally consisting of the alpha-solid solution, plus the deltoid constituent. To the presence of this latter constituent, distributed throughout the alpha-solid-solution, is ascribed the pleasing sonorous quality of bell-metal round about the 80:20 type of alloy.

The more uniform the distribution of the deltoid constituent the more likely is the bell-metal to possess a full rich tone.

Fig. 3 is from a photomicrograph of an alloy of the type mentioned, the deltoid constituent being the white portion. The etching reagents most suitable for the preparation of specimens of bell-metal for examination of the micro-structure are:—

(1) A solution of ferric-chloride, useful as a means of identifying the deltoid constituent, which is rendered visible as a bluish-white constituent upon etching the metal with this reagent.

(2) A solution of sodium-picrate, which reagent serves to darken the deltoid constituent.

The mechanical properties—at atmospheric temperature—of ordinary sand-cast bell-metal may be briefly noted. The tensile strength is round about 15 tons per sq. in. Those alloys with a tin content of 18 per cent. and over have zero elongation, and, generally speaking, are very hard and brittle; these properties are more accentuated as the tin content of the alloy increases. Annealing in the case of castings in these alloys renders the distribution of the hard constituent more uniform, with less liability of failure under the stresses set up by severe shock or repeated impact on the metal. By reason of the inherent brittleness of castings in the tin-rich cuprous alloys, the addition of other metals is attended with risk, and in some foundries no metals additional to copper and tin are intentionally introduced, the presence of any other metal which may be found in the casting being accounted for by the use of scrap.

Lead is often present to the extent of 1 to 4 per cent. The one-time popular idea that an addition of silver improved the tone of bells is without foundation, and is now abandoned; nor can the author justify on metallurgical grounds the sacrifice of the Chinese foundryman's daughter who plunged into a bath of molten bell-metal to ensure a soft tone for the temple bell about to be cast. It is a *sine quâ non* that exceedingly brittle metal should not be used in a bell casting, neither must the alloy be too soft; the useful life of the bell is to a large extent dependent upon its capability of resisting the effect of repeated blows.

The colour of good cast bell-metal has been described as "a peculiar gray-white." A newly fractured piece of cast bell-metal of the 80:20 type exhibits a white-grey, more or less crystalline surface, not infrequently spotted with small golden yellow patches; the presence of the latter is more noticeable in the absence of pressure feeding. The yellow patches indicate a lack of sufficient liquid metal to comply with the demand of "crystal growing" during the transition period which appertains as and when the metal as a whole passes from the partially liquid to the all-solid state. The bright yellow colour of the patches is due to the light reflected from the undamaged natural surfaces of the members of the partially-formed crystals.

The dendritic structure of a newly-fractured piece of bell-metal, as viewed under the microscope, is characteristic of the high tin bronzes when cast at suitable temperatures, and the structure serves in a useful way to grade these bronzes in relation to the percentage of tin in a particular alloy.

The compounding of a mixture of copper and tin to form a bell-metal alloy is not difficult. The bronze may be either ingotted or remelted, or made and used direct in a casting. The manufacture of ingot bell-metal follows the usual practice carried out in the making of ordinary high-grade bronze ingot, and calls for no special remarks. The furnace charge for the casting of large bells is generally prepared from either ingot copper or heavy scrap copper, an addition of a liberal weight of old bell-metal, if available, is often favoured. The requisite quantity of tin is added before tapping; the weight of tin to be added depends largely upon (*a*) the quality of the alloy desired, (*b*) the weight of copper included in the charge, (*c*) the weight and composition of the scrap. When large quantities of copper are melted "poling" is sometimes resorted to in order to bring the copper into its best condition. Charcoal is added to the furnace charge, and furnishes a suitable cover to protect the metal. For large casts an open-hearth air-furnace is generally employed, and proves quite suitable for this purpose. Pyrometric control of the melting and pouring temperature is desirable when the best results are demanded.

W. L.

MR. A. E. HADLEY, proprietor of the Star Foundry, Cox Street, Coventry, died recently at his residence, Arcroft, Rosemary Hill, Kenilworth, at the age of 44. Prior to establishing himself in business he was associated with the Britannia Foundry, Coventry.

SIR MAX WAECHTER died recently, at The Terrace House, Richmond, in his eighty-eighth year. Sir Max Waechter, who was knighted in 1902, was born at Stettin, Germany, in 1837. He came to England at the age of twenty-two, and was naturalised in 1865. He founded in the City of London the business of Bessler, Waechter & Company, Limited, of which he was for many years chairman and governing director. He also became interested in several steamship companies.

Making Propellers.—V.

By Ben Shaw and James Edgar.

LOAM MOULDS.

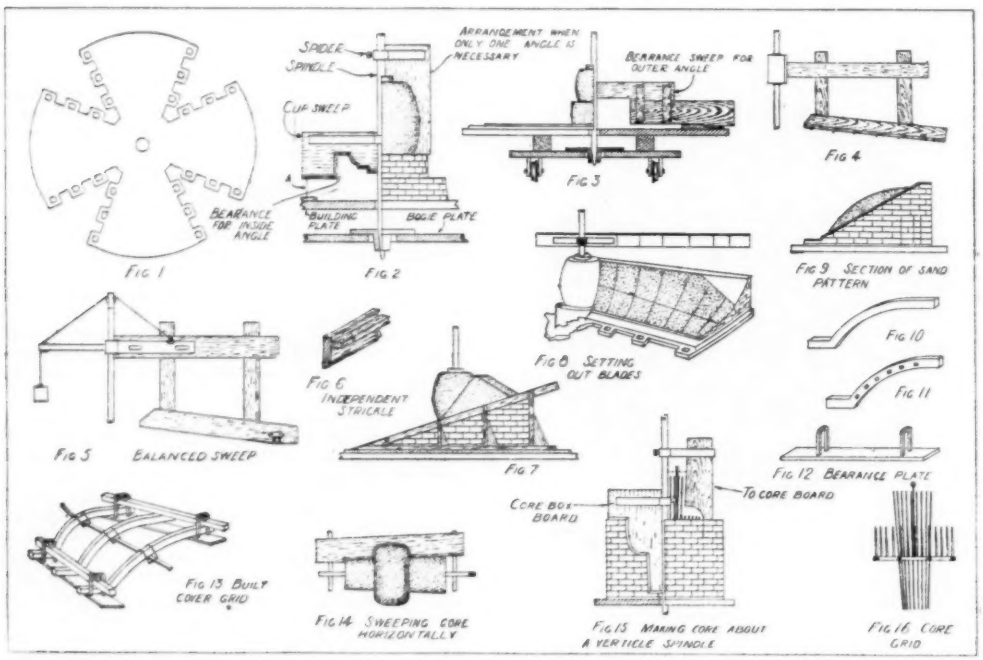
Loam moulds are invariably prepared for large propellers, particularly for those known as solid propellers, in which the blades and boss form one casting. While this is the recognised form of mould for this class of work, the manner in which the moulds are prepared vary considerably in different districts. This does not mean that the principles involved in their construction differ, but rather that they are applied in a variety of ways. It is not altogether satisfactory to discriminate and say that one method is superior to another. Moulders are conservative in their methods, and adhere to those that give reliable results.

In some instances much patternwork of an elaborate character is supplied which does not reduce the actual work in the foundry, but which may be considered to give greater accuracy in use. On the other hand, others seem to have the minimum of patternwork and apparently obtain accurate results. Many firms that order a propeller from a foundry supply the patternwork they consider to be necessary and endeavour to make what they supply fool-proof, and the work in the foundry is frequently increased in consequence.

It is not uncommon to have the boss and blade surfaces set up higher than they need to be, necessitating one or even two rows of bricks that could well have been dispensed with, and which would have brought the mould nearer to the building plate surface. The minimum patternwork is made at the foundry, where a drawing only is supplied, particularly if the foundry has specialised in this class of work, and as a rule the casting can be produced in less time. A foundry that specialises in cast-iron propellers can cast a 6-ton propeller in three days when the work is really urgent, and can generally be depended upon to cast the average sized propeller in four days, when the drawing only is supplied and the patternwork is prepared by the foundry patternmaker. In this article we shall describe the principles involved in the making of loam moulds for propellers and show some of the methods that are used in their application.

Building Plates.

All moulds of this type are built on plates. Ordinary circular building plates may be used possessing convenient lifting lugs about the outside. This form of plate is used more specially in iron foundries, where it is the custom to prepare the mould in a pit. This method is generally adopted when the facilities for stove drying are inadequate, the mould being dried in the pit. A circular building plate is also frequently used, even if the mould is prepared for stove drying, when the finished mould is lowered into a pit to be cast, or by those foundries where propellers are only occasionally made when a circular plate has greater utility. In foundries that specialise in this class of work special plates are generally made similar to that shown in Fig. 1. This design is especially desirable when the mould is prepared and cast on the foundry floor. The openings facilitate building, as they give access for the moulders when preparing the mould, and the lugs are invaluable for securing the mould when clamping up for casting. The plate represented is suitable for a four-bladed propeller mould, and it may be fitted to rest upon wheels, so that the plate forms its own bogie, or simply as a flat plate which is supported on a separate bogie. The diameter of the plate should be at least 12 in. larger than the required propeller, and its thickness from 3 to 3½ in., depending upon the size of work. Short gaggers are invariably cast on the working side.



Preparing Bearances.

When a suitable spindle, about 2½ or 3 in. dia., has been located having a spider attached, a beginning may be made on the first bearance. This consists of the cup for the boss, and, in some instances, a bearance for an inside angle, as described in the last article. The cup sweep is fixed to the spider, as at Fig. 2. It is usually necessary to set this sweep some distance above the plate surface, especially when the centre of the blade is set back in order that the blades when shaped will be in correct relation to the boss. The cup board should, therefore, be set above the plate a distance which will allow the trailing edge of the propeller to be about 1 in. above a bearance that has to be swept for the outside angle. When the cup sweep is made sufficiently long to complete the whole bearance at one operation, it is then only necessary to set it so that the gaggers are first cleared.

When two boards are used and a bearance is swept for an inside angle, the distances between

the bearances required should be marked on the cup board and checked at A, Fig. 2, when set. It will be noticed that the cup is swept first, when it would apparently be better to sweep the bearance for the outer angle first and set up the cup the required distance from it. This is, of course, frequently done, but the work is held up in consequence. By sweeping the cup first the loam stiffens during the time the outer bearance is being prepared, and a commencement can be made to sweep the boss as soon as the outer bearance has been completed. When the boss is completed the bearances are in a condition to receive the angles. Thus there is no delay to enable the loam to stiffen.

One method for sweeping the outer bearance is shown at Fig. 3. This is an excellent method when only one angle or race is to be used, the recess ensuring its accurate setting. It will be noted that the board shown has a level top, which is the alternative method to a narrow board set at an angle. When a few angles are used, either because of varying pitches or for sweeping curved blades, it is convenient to fix nails in the edge of the sweep so that the correct positions for the angles will be marked on the bearance. In addition to these guides for setting the angles, centre lines must be marked on, and their position with regard to the plate depends upon the particular shape of the blades. It must not be taken for granted that the centre of a blade will be on the centre of that part of the plate on which it is built.

Sweeping the Boss.

A pattern is usually swept in loam in preference to constructing a wood pattern, because it can be prepared quickly. The sweep for the purpose is secured so that it completes the shape commenced with the cup board. It is advisable, when setting this sweep, to allow it to rest on a piece of hoop iron so that, when it has been fixed and is rotated, the end will be clear from the cup bearance. The boss pattern is built up with bricks and loam, the board defining the shape. The minimum of bricks should be used, as very little strength is required, and it must be remembered that they have to be removed one by one when stripping.

Setting Angles.

On completion of the boss pattern the angles can be located. In many foundries the patternmaker is made responsible for this part of the work. When only one angle or race is used he will generally satisfy himself that the boss is set to suit the bearance upon which the race is to be set. Locating the position of the angle is then comparatively simple, but it should, of course, be set so that the blade will occupy the most suitable part of the plate from the point of view of covering. When one angle is used the patternmaker is also responsible for fixing the sweep that rides upon it.

When more than one angle is used more care is necessary in setting them and in maintaining their positions in correct relation to each other. Such angles are, as a rule, made from sheet iron or of light iron, riveted together with two or three supports from the bearance. It is essential that their centres should correspond with the centre marked on the bearance, and they should be square. Since the bearance is green and the iron angles, being thin, are liable to sink, it is essential that this possibility be guarded against. Thin pieces of hoop iron placed under the angles will suffice, and, while they are held in a vertical direction, bricks and loam should be built against them to give support. It might be stated that, while sheet iron angles are generally made for those required near to the boss, the light iron angle, with a few supports, is more suitable for intervening positions between the boss and tip, because it does not break the continuity of bricks forming the bed, and also because it is more easily withdrawn. When more than one angle is used, the sweep that is used is independent of the spindle, unless, as was referred to in the last article, the outside race carries two angles.

Building and Sweeping the Blade Surfaces.

Once the angle or angles have been accurately set for one blade, the building of the surface can proceed. Care should be exercised in so building that reasonable security in drying is assured. A considerable quantity of loam is used in the process, and, unless it is built to facilitate thorough drying, troubles may result when casting. Some moulders make their brickwork fairly solid, but introduce ashes in order that the structure will be porous. Others open up the brickwork at the back of the blade surface, particularly near the boss. Both methods will give good results, but it is essential to make some provision that will not only assist in getting rid of air and gases, generated when casting, but will materially assist the rapid drying of the mould. The brickwork is built up, the bricks not being less than $\frac{3}{4}$ in. from the surface, and loam applied. This is strickled or swept to form the blade surface. Some different forms of sweeps have been referred to in a previous article, and, in Fig. 4, is shown a box attachment on the spindle carrying a sweep which makes recesses in the surface for locating thicknessing sections. This form of sweep is often used by firms whose primary work is the making of bronze propellers having a true or regular pitch. It is convenient and more accurate to introduce a small metal roller to ride upon the angle.

The balanced form of sweep shown in Fig. 5 is a very common form for true screws, and it can be adjusted for sweeping the required surfaces, when the propeller is required to have a coarser pitch at the tips than at the boss, by making the double sweep as mentioned in the last article. The balanced sweep necessitates very little effort on the part of the moulder, it being a little heavier than the weight, travels on the angle as it is rotated and only a slight lift is required to restore it to the top of the angle for repeating the sweeping. When two or more angles are used another form of sweep must be employed. This simply consists of a straight-edged strickle similar to that shown in Fig. 6. A strip of iron reinforces the working edge, and as a comparatively narrow board is generally prepared, a stiffener is screwed to it, which not only keeps the strickle straight, but also keeps the loam in advance of the sweep when in use. When a strickle is used that must be used between corresponding points on two angles, some skill is needed in the operation to obtain a satisfactory surface, and this is acquired by men who frequently use this method, and the results are quite reliable. When one blade surface is completed, the angle or angles are removed and set up on the next bearance, and the process repeated until all surfaces have been completed. An end illustration of a swept surface is shown at Fig. 7. It is important to prepare joints at the top and bottom of each blade surface to facilitate covering. This should, of course, be done at the time of building. When all surfaces have been prepared the whole should be dried.

Setting Out the Blades.

After having been dried, the contour of each blade is required to be marked out, and invariably the pitch is checked. Some firms send a draughtsman to the foundry for this purpose, while others rely upon a patternmaker. When the work is left entirely to the foundry, a patternmaker invariably prepares the work for the moulder. This part of the work is apparently difficult, but anyone familiar with the principle of the screw and who is capable of reading a drawing should have no real difficulty in doing what is required. The first thing to be done is to mark a number of concentric arcs of convenient diameters on each surface, make them coincide with the distances from the vertical centre for which the thicknessing sections have been made and those generally shown on a drawing on which the various widths of the blade are defined. When a fixed sweep is employed for the surfaces, nails driven in at the required distances from the centre will define these arcs on the surfaces, but when an independent strickle is used these arcs must be marked out after drying. A convenient way is shown in Fig. 8. This consists in fixing a parallel straight-edge horizontally to the spindle and marking the required distances along it from the centre, which can be projected to each blade surface. Anyone with a little ingenuity can quickly devise a projector, which, when held on the straight-edge and rotated with it, will allow a perpendicular rod to slide down so that a line is scribed on the loam surface. When

these arcs have been marked it is advisable to check the pitch. For this purpose a pitchometer is used, which determines the angle of the surface to the horizontal.

The angles vary at different distances from the centre, of course, but when obtained it is comparatively easy to calculate the pitch at a particular distance from the centre. Multiply the tangent of the angle obtained by the circumference of the arc from which it is taken, and this will give the pitch. As a rule tables are supplied with a pitchometer, from which the pitch can be readily obtained. It is not necessary to check every position on the surface, nor all the surfaces, unless the results are irregular and necessitate slight alteration of the surfaces to the requisite pitch. It is advisable, as previously mentioned, that the pitch at the tips be slightly coarser than required to allow for the drawing of the casting when cooling. After checking the pitch the blade centre lines should be marked. The parallel straight-edge can be used for locating points, one near the boss and the other at the extremity of the blade, through which a straight line can be drawn. The distances from the top of the boss can be obtained from the drawing, and the height of the straight-edge above the boss can be added to these dimensions and measured vertically to the loam surface, thus obtaining the points for drawing the blade centre. The various widths of blade can then be set off and nails knocked in the loam to define the points through which the contour of the blade passes. Each blade requires marking off in this way. The patternmaker then locates and temporarily fixes the thicknessing sections with moulders' brads, completing the operation of setting off.

Thicknessing.

The presence of the section pieces constitute a form of skeleton pattern. Sand is rammed between them, as in Fig. 9, and strickled off to represent the full shape of a blade when the sections and the rod iron, or strip wood, is transferred to the next blade, where the process is repeated. When the rod iron defining the shape of the blade is removed the sand blade is rounded off, but the edge is left thickened. When all have been treated in a similar manner a complete temporary pattern will have been formed. Fillets should be formed between the blades and boss according to requirements, and when completed preparations can be made to form the covers.

Covering.

There is much diversity of opinion among foundrymen respecting the best form of cover to provide for propellers. Some use a flat plate carrying gaggers, which is bedded into a loam covering, while others have very elaborate grids built to carry the covers for each blade. For general work two forms of covers predominate, and they have much in common. Both are what might be termed grids, and one form corresponds to that illustrated in Fig. 13. These are built in place, the procedure being as follows:—Two carrying plates, which have short gaggers on the under side, are bedded in loam previously applied to the joint bearances above and below the blade. On these are placed three stout bars like that shown at Fig. 10. In foundries that are frequently making these castings there is usually a stock of such bars of various shapes. Two strong tie bars are passed through the staples and firmly wedged to make the whole secure. A covering of loam is next applied all over the blade, and hangers are suspended from the main bars, through which are placed wrought iron bars about 2 in. × ¾ in. in section. These are clay washed and bedded into the loam to about 1 in. of the blade. A sufficient number is used to form a network over the whole surface, and packing pieces are wedged between them and the main bars. This completes one form of cover. The other varies from this in that the main bars are slotted as in Fig. 11, and, instead of using wrought iron, supplementary bars about 2 in. square in section are placed through the slots. The former method is advantageous in that the wrought iron bars can be bent to conform to the sweep of the fillet against the boss, and while it is not so rigid as the latter method, it is stronger. Bricks are generally used with the latter method, but not with the former. When all blades have been covered, and loam worked over the supplementary bars, a joint is necessary near the top of the boss. This can be made without delay, and, when stiffened, loam can be applied and a flat cover plate bedded on to it. The covered mould is then ready for transference to a stove for drying. Another form of grid which involves more patternmaking, and in which cast bars are made running from leading to trailing edge, and which was described in the last article, is more common in certain districts.

No reference has been made to arrangements for running propellers, although this would need to be allowed for in building the mould. The methods differ for bronze and cast iron, and to distinguish them might cause some confusion. As a rule, cast-iron propellers have an ingate to the side of the boss between two blades. Bronze propellers, on the other hand, receive the metal near the tips of the blades from a spray.

Making the Core.

The method of sweeping the core on a horizontal spindle is preferable, as shown at Fig. 14, when the finished core is small enough to be handled, but for larger cores that necessitate the use of a crane it is more convenient to prepare them about a vertical spindle. Light wrought iron rodding bent to follow the contour of the core will generally give sufficient support when it is small and is swept as indicated in Fig. 14. About four or five rods will suffice, and they should be bedded into the loam and wired on to complete the sweeping. In some instances two coatings of loam are affixed, the first being roughly swept and dried before sweeping on the finishing coat. When this is done it is important to make the final coating not less than ¾ in. thick, and it should be carefully wiped on the first coating so that it will bind.

For vertical sweeping a part core-box is prepared, as in Fig. 15. This is swept with a board secured to the spindle. The loam forming the core-box should be allowed to stiffen before commencing to build the core in it. A grid, such as is shown at Fig. 16, can be used advantageously for the larger cores that are made in this way. Wrought iron rodding is cast in the grid to carry the shape of the bore, and two lifters should either be bolted to or cast in the grid. The spider is removed from the spindle to lower the grid into the part core-box, which is bedded into loam. After the core is built up as far as the core-box will allow, a top sweep is fixed to the spindle to complete the shape. The centre of the core should be filled with ashes to facilitate venting. This method has the advantage of making the core in the direction that it occupies in the mould, and, when dried, it can be lifted without subsequent turnover.

Stripping and Finishing.

When both mould and core have been dried preparations are made for finishing. The temporary pattern requires to be stripped from the mould, and the covers must be carefully marked to indicate their positions before being lifted. The boss cover plate is the first to be moved, and it is advisable to strip the loam boss pattern before attempting to move any of the blade covers. As previously mentioned, the pattern is removed brick by brick. When this is clear the other covers can be lifted and the sand blades removed. As a rule, one blade is prepared at a time, the cover being suspended from a crane, where it is finished and blackwashed. When the same has been done to the bottom the cover is lowered into its relative position, but separated by resting a few bricks on the bearance, and the next one commenced. The boss is located in a similar manner. Replacing the covers on supports in their respective positions reduces the floor space that would otherwise be necessary to accommodate them, and prevents any likelihood of the covers being wrongly placed. When the core has been lifted and blacked, both mould and core are again stoved for final drying.

The swept blade surfaces are generally found to develop shrinkage cracks, which may cause some little trouble. If they are not filled in before blackwashing, the surface vein marks are produced on the casting, which can, of course, easily be

cleared off, but this injures the skin surface on the casting. On the other hand, if the cracks are indifferently fitted, the pressure of air and gases at the time of casting may force the filling against the metal, forming what is known as a dumb scab. When filling is done, the crack should be undercut and swabbed and loam carefully wiped in, otherwise it is better to leave it and have veins on the casting. Then in applying blacking some moulders are so liberal with the swab brush that practically all the blacking that has been applied has been washed off and the surface on the resulting casting bears testimony to the paucity of blacking actually left on the mould.

Assembling for Casting.

When both mould and core are thoroughly dry, the covers are located in their respective positions, the boss being the last to be set after the core has been lowered into position. Careful attention must be given to the clamping of the covers to the bottom plate. In many foundries the finished mould is lowered into a pit and sand rammed in to reduce the amount of local clamping otherwise necessary. This, however, involves considerable additional work, and is not really necessary, as if reasonable care is exercised in clamping to resist all possible pressures, the metal can be cast on the foundry floor. A special pouring basin should be grouted in position, and when the whole mould is finally clamped, metal can be cast into it. It is customary to have prepared bot sticks at hand when casting takes place in the open on the foundry floor in readiness to stop a run out. The necessity for their use is only rarely experienced, but it is advisable to be prepared should the necessity to use them arise.

Mechanical Flue Cleaning.

A very interesting apparatus that has now been perfected and placed on the market is the "Vulcan" mechanical flue cleaner, a production of The Boiler Tube and Flue Cleaner Company, Limited, 239B, Gray's Inn Road, London, W.C.2. This is a simple and ingenious invention by means of which the operation of cleaning steam boiler and economiser flues is carried out mechanically at short intervals, say once per shift, thus keeping the flues and boiler plates in a permanently clean condition, and is equally applicable for use with metallurgical and other furnaces. The arrangement consists essentially of a series of lengths of small bore steam pipes laid on the bottom of the entire flue circuit, having steam nozzles at short intervals. The supply of steam to these nozzles is controlled by a patent manifold valve placed in any convenient position, say over the side flues in the case of a Lancashire boiler. This valve is operated, generally once per shift, as already indicated, and the design is such that the steam is turned on for a few seconds first to the nozzles in the boiler furnace tubes and bottom flue section, blowing in front of it all the light dust that has accumulated from the previous shift. Then automatically, by the action of the manifold valve, the section of nozzles is shut out and the next comes into operation, and so on, in this way the whole of the dust in the entire flue circuit being blown right out of the plant, either into a receptacle chamber at the end or up the chimney. The total time of operation is 2 minutes, and the amount of steam used is extremely small, so that for this reason also there is no trouble with dampness.

Further it is extremely simple and almost impossible to get out of order, unlike some of the various types of complicated suction apparatus, working at high speed on the vacuum cleaner principle that have been proposed from time to time. No cold air is admitted, it is claimed that the annual inspection of a boiler can be made in less than 12 hours after pulling out the fires, and there is also a device of a drain cock normally open, in the steam supply pipe, so that when not in operation no steam or water can leak into the flues. A considerable number of plants are at work and giving every satisfaction so that the matter is certainly of interest to every steam user, and to many industries using furnace equipment.

Coal Dust and Mould Skin.

BY J. H. LIST.

If a casting has a good skin it satisfies the engineer, or his inspector, quite as much, if not more, than a casting being to size or that is sound. It is thus well worth while trying to obtain a good skin. Fortunately a casting that has a good skin is far more likely to be sound.

Moulding sand that is chiefly used by the ordinary jobbing foundries contains a fair amount of bond, and is therefore highly impervious to gases; it also contains a high percentage of foreign matter of a low fusing point; such a sand, therefore, must have its face well protected from the hot iron. Coal dust is the first and foremost of the materials to be mixed with the sand to give such protection.

Coal dust mixed in the proportion of 1 to 17 of sand for light castings, and 1 to 8 for heavy castings, is about correct for Mansfield sand. The proportion of coal dust must be such that from experience the best results have been obtained and no hard and fast rule can be laid down. It must always be borne in mind that the more black sand that is used in the mixing of the facing sand, the less coal dust will be required because it will contain portions of coal dust that have not been burnt.

This coal dust should be mixed with the sand by passing it through a disintegrator, and by this means it will be equally distributed, and will obviate the chances of having large bodies in one place which invariably happens if the moulder mixes it himself.

The hot iron entering the mould forces the coal dust to give up its gas, this gas will form a thin film about the face of the mould, and will prevent the iron from coming in direct contact with the face of the mould. This gas is either carbon dioxide or carbon monoxide.

In selecting coal dust, the following points can advantageously be considered:—its bituminous qualities, ash content, its volatile matter, and its proportion of fixed carbon. Too great a proportion of ash is most deleterious, and if used can only result in castings of a whitey-grey appearance with a very rough surface and probably contaminated with burnt sand.

On the other hand, if a coal dust of too high a carbon content be used with a necessarily low ash, the facing becomes too refractory a nature, and the coal dust is unable to carry out the functions for which it was intended. Coal dust made from the hard coals obtained in some of the Welsh coal fields is very suitable. Grist too is important.

For very light castings a fine mesh coal dust is necessary, particularly if the sand is open, while a slightly coarser, yet still fine grist for heavier work.

When coal dust of too coarse a grade is used, small pits are left on the face of the casting, and are easily distinguishable by their formation from those caused by particles of sand insufficiently milled. Under such conditions excessive gas is caused round about these parts, and the gas takes the path of least resistance which may be through the molten metal. Too much coal dust weakens the sand and is liable to produce sand cracks.

Where heavier castings are concerned the bigger weight of metal and the consequent increase available heat units prevents such pits, particularly as the blacking on larger moulds is used more liberally. When coal dust cannot be obtained, creosote oil, ground pitch and tar are good, but the fumes are unpleasant. Sawdust is also a substitute, but such large quantities are necessary, that it spoils the bond of the sand. Coal dust is not used with green sand for steel castings, because the gas formed would not withstand the high temperature and would be wasted. In making brass, phospher bronze, or gun metal, coal dust is frequently used when the mould is skin dried, but for green sand mould it is discarded in favour of a dusting of pease meal and French chalk.

Coal dust, if controlled as to proportion and mixing, and cognisance is taken of the temperature of heat units likely to be available from the liquid iron, is the principal means in the production of a good skin on a casting. Even then it is advisable to coat the mould face with plumbago or graphite.

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Discussion on Mr. J. E. Hurst's Paper on Pearlitic Cast Iron.*

This Paper was read before the first meeting of the 1924-25 session of the London Branch of the Institute of British Foundrymen at the Engineers' Club, Coventry Street, London, W.1, on Thursday, October 9, and has been printed in our issue of October 16.

THE BRANCH-PRESIDENT (Mr. V. C. Faulkner), in opening the proceedings, said it was usual to call upon the Secretary to read the minutes of the last meeting, but, unfortunately, Mr. H. G. Sommerfield (the Branch-Secretary) was very ill indeed, and was not at all likely to be able to take any part in the proceedings of the Institute for many months. He (the Branch-President) was sorry to have to give the members this news, but he was sure they would allow him to convey to Mr. Sommerfield their best wishes for his recovery.

Presentation of Diplomas.

Continuing, the Branch-President said that his next duty was a very pleasant one, because it fell to his lot to present diplomas which had been granted by the General Council of the Institute to two members of the Branch. The first was to their Past-President and very good friend, Mr. A. R. Bartlett, for his Paper on "A Day at the Cupola." (Applause.) Mr. Bartlett was the very best friend the Institute had ever had. He must have travelled thousands of miles on their business, especially during the war, when travelling facilities were poor; also, whenever the Branch had been short of a lecturer, Mr. Bartlett had invariably stepped in. In addition to his administrative work, his Papers had been of very definite interest; they were always of a good, practical and technical character.

The diploma was then presented, amid applause.

MR. A. R. BARTLETT expressed his thanks to the Branch-President for his kind remarks, and to the members for the manner in which they had responded to them.

THE BRANCH-PRESIDENT said the second diploma was to Mr. J. W. Gardom, who was an ideal member. The first time he had attended a meeting of the Branch he had made some very constructive remarks, and since then had been one of the very best members. He had read an excellent paper, and at every meeting they could look forward to some remarks from him, which carried the subject under discussion a little further, which they all appreciated.

The diploma was presented to Mr. Gardom, also to the accompaniment of applause from the members.

MR. GARDOM expressed his thanks.

Lanz Pearlitic Cast Iron.

THE BRANCH-PRESIDENT then introduced the lecturer, Mr. Hurst. He (the Branch-President) was responsible for the subject of Mr. Hurst's Paper, which was one of very definite interest to all cast-iron foundry people. The least one could say about it was that, if it did nothing else, it would resurrect the interest of the British foundry trades as to what was the best composition for cast iron, and what was the best test one could expect to get out of it. The members were to be told that evening, he understood, exactly what the Lanz pearlitic cast iron was, and how it differed from the pearlitic cast iron which had been made in this country for a considerable period in large quantities.

THE BRANCH-PRESIDENT, in opening the discussion, said it would be agreed that they had had a most interesting Paper, but, unfortunately, they were still left in the air, inasmuch as Mr. Hurst had been unable to say exactly whether they must regard the Lanz pearlitic cast iron as a serious product or as a quack material. He gathered, however, that, providing certain factors were regulated, then it was a material worthy of the serious attention of foundrymen. Although the moulds were heated up to a certain temperature, apparently the patentees were not taking mass effect into consideration. By that he meant that, if the wall of the mould were only ½ in. thick, it would not have the same effect as if the wall of the mould were 2 in. thick, because the rate of cooling would vary with the thickness of the mould, although it was heated to the same definite temperature. Some of the members of the Branch would remember that, at an exhibition at Olympia, they were taking test pieces of about 1 in. diameter of electrically-melted iron made by Summerson, of Darlington, and those test pieces regularly gave about 19.9 tons per sq. in., so that the figures given for the Lanz product were roughly 4 tons per sq. in. better than the best normal material they could get from British manufacturers.

Continuing, the Branch-President said he had had a note from Mr. J. G. Pearce (director of the British Cast Iron Research Association), who had had to leave the meeting before the conclusion of the lecture. Mr. Pearce had prepared a confidential document, which had been issued to the members of the British Cast Iron Research Association, and, generally speaking, his views coincided fairly well with those of Mr. Hurst, namely, that more information was needed in regard to this material. There seemed to be something in it; everybody agreed that the patentees were proceeding on the right lines, but there were certain factors which were still wanted.

Insufficient Details Available.

MR. F. A. MELMOTH said the lecturer had laid considerable stress on the fact that very little definite information was available, and he agreed that to all intents and purposes our knowledge of the subject was limited to what had been published in the technical Press. He himself was very interested in the constitution of cast iron, and he would like to know whether the lecturer considered there was anything in the following theory bearing on the reasons for the Lanz pearlitic cast iron possessing certain unusual properties. He tentatively suggested that the pearlitic condition in what would be, when normally cooled, a white iron was caused by the retarding action of the hot mould slowing down the cooling to such an extent as to cause the partial or complete decomposition of the normally-formed massive cementite. He would take, for example, a white iron of a composition used for producing American black heart malleable. Its composition was somewhat similar to that mentioned by Mr. Hurst, being, total carbon, about 2.5; silicon, 0.7 to 0.9 (depending on the thickness of the sections required); manganese, 0.3 to 0.4; sulphur, 0.05; and phosphorus, 0.2 per cent. The actual micro-structure of such an iron, if cooled in the ordinary way, would consist of massive cementite in a matrix of pearlite.

In this case, looking at the cooling curve drawn by Mr. Hurst, it would pass through the solidus line, and below that point would form massive cementite, the pearlite being formed at a lower temperature, approximately 760 deg. C., or perhaps a little lower than that. If, however, any retarding influence were placed upon the cooling of that iron, so that it passed through the middle range, say, between 1,150 and 760 deg. C., at a much slower rate, the possible tendency would be towards the decomposition of the already-formed cementite with the production of secondary graphite. Taking the same alloy, and subjecting it to sufficient temperature with quite a short treatment, the result obtained would be a pearlitic structure containing small scattered amounts of graphite.

It appeared possible to him, therefore, that the Lanz process being based on the retarding of the cooling during the period between 1,150 and 760 deg. C., allowed, therefore, a sufficient time for the formed cementite to commence to decompose or entirely decompose. It had been asked by the Branch-President whether the Lanz process was to be considered as a quack process or a something which would become really valuable. Personally, he did not think at the moment that ordinary

* See issue October 16.

works conditions could so co-ordinate composition and temperature of mould that such a matter as this could become a definitely practical proposition. As an instance of this, Mr. Melmoth asked how many castings came their way in which one definite thickness of the casting could be relied upon right through. In very many cases they were asked to produce castings which were ½ in. thick in one place and 2 in. thick in another. In such a case were they to alter the composition for any one part, or the rate of cooling for any one part, or the local heat to which they subjected the moulds? If it were possible to do none of these, would they, with this particular reaction, the possible decomposition of cementite—assuming it to be that—obtain equal structures in the 2-in. and ¼-in. sections? He doubted it. Therefore, it seemed that ordinary foundry practice would only be adapted to the conditions necessary to produce pearlitic cast iron with extreme difficulty.

Old Cannon show Pearlitic Structure.

Mr. Wesley Lambert (Past Branch-President) congratulated Mr. Hurst upon his lecture, in which had been brought out a great deal of matter of considerable interest. When a man could lecture for an hour and a-half on a subject with regard to which he had admitted there was little information available, all would agree that he had done remarkably well. The high tensile figures which Mr. Hurst had given for cast iron reminded him (Mr. Lambert) of a number of thin-wall cannon which were broken up as scrap some thirty years ago. The members would probably have in mind cast-iron cannon with rather thick walls, but in those days there were quite a number of old cannon having comparatively thin walls—anything from 2½ in. at the breech to 1 in. at the muzzle. At the time these cannon were broken up under the steam-hammer, he had secured some pieces for test purposes, and it was not an uncommon occurrence to get round about 20 tons tensile from that cast iron. He had examined the metal under the microscope, and found that it possessed a structure which to-day would be regarded as of a pearlitic character. Mr. Hurst, in the course of his lecture, had spoken of grain size, and that had a very important bearing on the tensile strength of the iron, as also had the character and distribution of the graphite. If large flakes of graphite segregate out, one must not expect to get very high tensile figures. In the particular iron secured thirty years ago which he had examined, the graphite certainly was in a very fine state of division. Mr. Hurst had said that graphite does not necessarily follow the boundaries of the crystals. From that it might be gathered that he wished to infer that the graphite was present as a component part of the actual crystals, but he (Mr. Lambert) was not of that opinion. In every instance in which he had examined the metal the graphite was merely entangled amidst the crystals of pearlitic iron which go to make up a grain. One should differentiate between a crystal and a grain. The actual crystals of iron of a pearlitic character contained, so far as he was able to ascertain, no graphite whatever, but amidst the conglomerate of the crystals of pearlitic iron forming a grain, the graphite is found entangled between the boundaries of adjacent crystallites.

With reference to the iron carbon diagram, it should be distinctly understood that it was an iron-carbon diagram, *i.e.*, a diagram of the two elements, iron and carbon. There was no doubt that it could be modified by the other constituents present in cast iron, and, although they looked upon pearlite as requiring 0.89 per cent. combined carbon, it was just possible, and not at all unlikely, that the other elements in commercial cast iron may exert an influence, and that it may be possible to get an almost wholly pearlitic structure, if not a true pearlitic structure with a content of combined carbon of less than 0.89 per cent. He regarded the iron-carbon diagram in much the same way as he did the ordinary copper-zinc diagram. There were certain co-efficients for use when other elements were introduced into a copper-zinc mixing in the making of the complex brasses, and by a series of simple calculations the modification in the micro-structure caused by the introduction of such elements can be anticipated. He believed that in course of time the full influence will become known of the other elements additional to the essential iron plus carbon constituents of commercial cast iron. The iron-carbon diagram will be further elaborated, and the manufacture of commercial pearlitic cast iron may possibly be arrived at in more ways than one.

Commercial Aspect of Pearlitic C.I.

Mr. J. Smeeton (a visitor) said that Mr. Hurst had spoken in a most enlightening manner for an hour and a half on a modicum of information which he had said he had gathered from an ancient patent and various articles in technical journals. The Diefenthaler patent, said Mr. Smeeton, was somewhat old, and, since Diefenthaler had joined the Lanz Company, that Company had spent many years on experiment and research. He was informed that, as a result, there were three later patents, the provisional applications for which were passing through the Patent Office, and would be published shortly. They would probably throw a great deal of light upon the methods by which the Lanz Company claimed to produce consistently pearlitic structure castings. He himself was only interested in the production of pearlitic castings from the point of view of giving English foundries something which would enable them to turn out a superior product, with more lasting efficiencies, and he was of opinion that, considering the lack of available knowledge of the Lanz process, it could only be assumed, from the fact that the Lanz Company were selling licences to some of the most important foundries in Europe and other parts of the world, that they must have arrived at something more or less definite. Mr. Hurst had mentioned that there was no data given in regard to the pouring temperatures of metals, or the degree of heat which must be applied to moulds for castings with walls of variable thickness, or any definite information with regard to the cooling-down period. He (Mr. Smeeton) believed they would find, when they inquired further into the Lanz process—which, after all, appeared to be a defined method of producing consistently pearlitic structure castings—that all these factors had actually been arrived at, and that the information would be placed at the disposal of founders who were seriously inquiring into the methods of manufacture; any founder who was sufficiently interested to become a licensee of the Lanz process would have all this information placed at his disposal, so that he would be able to manufacture these castings, which, apparently, had some advantage. Recently, said Mr. Smeeton, he had made a tour of England, and, wherever he went, he had the claims of this Lanz pearlitic iron process thrown at him for discussion. He had happened to become associated with the Lanz process—knowing nothing at all about cast iron or foundry work generally, and being a mechanical engineer of certain ability—and he was accused of trying to force on the market some process which was going to upset everyone's existing ideas and practice; he was threatened with all sorts of dire punishment for endeavouring to tread on the corns of investigators in this country, though there was no reason for him to be accused of doing anything of the sort. His view of the position was this: Had the Lanz Company obtained a patent which was of value? Did their patent enable any individual foundryman to produce a casting which was superior to a normal casting, which would economise machining costs, which would give a higher tensile strength, some ductility, and all the other advantages claimed by the Lanz concern for castings produced by their method? Apparently the Company had been able to convince some 18 of the most important engine builders and other specialised manufacturers in Europe. They had not yet convinced anyone in England, although recently quite a number of foundrymen had been in Germany investigating the process, and their reports would eventually be published, if not to the public, at least to their boards of directors. To set his (Mr. Smeeton's) mind at rest, he had thought the best thing to do was to ask the Branch-President (Mr. Faulkner) to go to the Continent personally to investigate the question, not only in the Lanz works, but in the works of some of the most important licensees. Then he would perhaps be able to say whether the Lanz process was quack, as mentioned, or whether it was real. Mr.

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Smeeton suggested that, considering the small amount of real practical knowledge available, they should leave the matter over until the Branch-President was in a position to address the members of the Branch and place before them the results of his investigations, and his real opinion as to whether the claims of the Lanz Company were justified, and whether the process was of any value to them all, as foundrymen and engineers interested in the economic production of high-class castings.

Heat Treatment of Moulds not New.

Mr. A. R. Bartlett (Past Branch-President) spoke of the difficulty of getting a mould to such a temperature that would give an even rate of cooling over the whole mass of a casting, through the thickness of the casting being varied. It was quite common practice, he believed—at any rate, it was so far as he was concerned—to make test bars in a dry-sand mould, and to keep that mould in the stove until the last moment of cooling. The metal was cast as hot as they could get it, and, after casting, the mould was taken back to the stove and left until it was practically cold. Under those circumstances, it seemed to him that the Lanz process was somewhat the same as that followed in order to fake the test bars. (Laughter.) It was not a true reading of what the actual casting would be. As to the analysis given by Professor Bauer, he (Mr. Bartlett) would take that to be quite a good analysis for the heavy type of cylinder casting, and the figures Mr. Hurst had given corroborated that.

Cost of Process.

Mr. H. O. Slater (Past Branch-President) said that he looked at the matter from the practical point of view, as had Mr. Bartlett, and it seemed that the lecturer had dealt with it rather from the scientific aspect. With regard to the heating of the mould to a particular temperature to suit a particular section, this would be, in his opinion, a very costly proposition.

The Branch-President said it increased the cost by 15 per cent., according to the German investigators.

Mr. Slater pointed out that it would be rather difficult to heat a fair-size loam mould to a particular temperature, and it would be an expensive operation. It all came back to the question of annealing. He had in mind some small boxes made for electrical apparatus. When cast in ordinary iron it certainly solidified much whiter than they had anticipated. They thought it best to follow common practice and put them in a muffle, cover them with sand, and anneal them for a few hours on similar lines as they would malleable iron, only in sand instead of iron ore; that was successful. He believed the German process was not altogether new, because many old foundrymen knew the value of annealing or holding back the cooling of iron, in order to get a soft and ductile machining iron. Were pearlitic cast-iron castings made by this process sand cast, or cast in a permanent mould or chill?

Mr. Smeeton said they could be cast in any form.

Mr. Slater, although he reiterated his point that the heating of a mould to a particular temperature involved considerable expense, agreed that if the material would do all that the patentees claimed for it, it would be very acceptable to the motor industry; he himself, as an amateur motorist, would very much appreciate a better cylinder.

Low-Silicon Iron.

Mr. J. W. Gardom, after commenting on the instructive nature of the lecture, said that he was particularly interested in low-silicon iron. Without considering, at the moment, whether or not it was possible to produce iron with the properties mentioned by Mr. Hurst by means of the Lanz process—though really he believed it was possible—he could not see that it was going to be a commercial proposition. In his own particular class of work he had produced grey iron, or what should have been grey, but which had turned out white iron, and that was rather trying. With a normal composition iron, with 2½ per cent. silicon, in a section 1-in. thick, he had obtained white iron. Another, containing 1 per cent. of silicon, turned out to be mottled. That sort of thing was very trying, and made them wonder whether it would be commercially possible to bring all the varying factors down to such fine limits as to enable them to produce exactly what they wanted every time. He knew, for instance, that given an iron containing 3 per cent. total carbon, 1 per cent. silicon, 0.7 per cent. manganese, and 0.1 per cent. sulphur, if they raised the sulphur content from 0.1 to 0.15 per cent. they could get a serious variation in the appearance of the castings, though they were of the same size. It was possible, in an ordinary sand casting, with a 1-in. section, to produce a mottled effect, and, in a 2½ per cent. silicon iron—the ordinary grey iron—by taking it to a temperature of about 920 deg. and quenching it in water, they produced, of course, a white iron; by annealing that for from half an hour to an hour above 700 deg. they produced an almost entirely pearlitic iron. They usually found many cracks in it, however, and, if they did produce pearlitic iron, they were bound to get that result. Pearlite would naturally give a higher tensile strength, greater resistance to wear, etc., but he considered that the difficulties to be overcome were almost insurmountable.

Mr. Wesley Lambert, referring again to the old cannon he had mentioned previously, said that pictures showing the method by which they were cast were in existence. Iron moulds, presumably lined with a thin coating of loam, were employed, and a wood fire was lighted around the outside of the mould to make it hot at the time the metal was being poured.

THE AUTHOR'S REPLY.

Mr. Hurst expressed gratification at the lengthy discussion his Paper had provoked. Dealing with the matter generally (as he understood it) he said that the position in regard to pearlitic cast iron at the present time was that the definition given by Prof. Bauer—the definition as laid out in the only existing patent specification of the Lanz process, was an extremely good one, and was of considerable interest to foundrymen, as offering a possibility of getting, in many cases, a better iron than they are able to produce at present. Whether pearlitic cast iron would be universally applicable to all types, shapes, sizes and conditions of casting was another matter. If reference were made to Prof. Bauer's Paper, and to some of the other articles published with regard to pearlitic cast iron, it would be found that there was a tendency to adhere strictly to cylindrical castings, such as cylinder liners and piston ring drums. If they considered the matter from the point of view of the making of cylindrical castings, many difficulties would be overcome, and Mr. Hurst considered it a mistake to endeavour to interpret the definition in the terms of all the shapes, sizes and conditions of casting that occurred in modern practice. He did not think Lanz would like to claim that. The only point was that, so far as the information derived from the published patent specification and published articles went, the definition itself held out promises of an extremely useful invention. The unfortunate part was that none of the examples quoted up to the present time complied strictly with the terms of the definition, and that accounted for the fog they were all in. Where were they? When the examples of Prof. Bauer—an authority on cast iron in Germany—did not comply strictly with the definition, and when he avoided (whether intentionally or otherwise Mr. Hurst did not know) the direct issue of comparing his iron, cast by pearlitic method and cast normally, it made it extremely difficult for them to consider the subject of pearlitic cast iron, and to attach any importance to it. None of them was asking the inventors to give any information which was of commercial value, and which they would, naturally, expect to be paid for; all they asked for was information which would enable them to gauge the value of the pearlitic process. That information could be supplied quite easily, and he (Mr. Hurst) suggested to Mr. Smeaton—who was, he understood, a representative of the Lanz process in this country—that he should urge his principals to give the results of tests on a 1¾ in. dia. test bar, cast according to the pearlitic method and according to ordinary sand-casting methods.

Mr. Smeaton pointed out that the Branch-President would be able to do that when in Germany.

MR. HURST said that would prove conclusively whether or not there was any merit in the process. The question was quite capable of simple proof, and it would set their minds at rest at once. If the Branch-President were satisfied that the results claimed could be regularly obtained, then that would at once demonstrate the commercial value of the process.

Dealing with Mr. Melmoth's suggestion as to what he considered were the features underlying the pearlitic cast iron process, Mr. Hurst pointed out, in the first place, that Mr. Melmoth mentioned a silicon content, which was lower than those mentioned in any of the writings connected with pearlitic cast iron. Mr. Melmoth had mentioned 0.7 and 0.9 per cent. silicon contents with which the difficulty of getting graphite in the structure with any normal rate of cooling, as apart from annealing, was well known. From what he (Mr. Hurst) could gather, after reading the published matter on pearlitic cast iron, the rate of cooling was not very much longer than it would be in normal grey iron foundry practice. In any case, there was no semblance of any annealing, except in the alternative methods which were suggested, but which were not described. Secondly, if Mr. Melmoth would refer to the micro-photographs in Prof. Bauer's Paper, he would see at once that the free carbon deposited in pearlitic cast iron was not of the type which would have been expected from the secondary formation of graphite during an annealing process. That would be of the type similar to that which appeared in micro-photographs of malleable castings. In Prof. Bauer's photographs large flakes of graphite, indicating that it was a primary graphite formation were to be seen.

Pearlitic Structure to be where most Needed.

Mr. Hurst, replying to the Branch-President, said that the mass of sand would not have very much influence on the process; the sand had such an extremely low thermal conductivity that the difference between ½ in. and 2 in. thickness of sand, in the time taken to produce the casting, would have very little effect indeed, providing it was all at a constant temperature, which, presumably, Lanz desired. He believed the Branch-President had in mind a motor car cylinder, with a cylinder wall, say, ¼ in. thick and a holding-down flange about 1 in. thick. If Lanz desired a temperature of 200 deg. C. for his mould wall in one place, then, if they adhered strictly to the patent, they would expect a mould wall temperature of 100 deg. C. in another place. The practical difficulties of getting those differences of temperature in one sand mould were enormous, and he did not think Lanz seriously intended that there should be any attempt to do that. In considering a motor car cylinder he would probably reason that the most important part of the cylinder was the cylinder wall, and that was where the high resistance to wear was wanted. Therefore, if the conditions obtained were such that they had an all-pearlitic structure in the cylinder wall, that was as much as could be expected practically. Thus, he would arrange his average mould temperature at 200 deg. C. Whether he obtained an all pearlitic structure in the flange did not matter to him very much. That, after all, was not so very different from the line of reasoning in ordinary foundry practice. They would say, for instance, that in a ¼-in. section it would be necessary to have a silicon content of 2.5 per cent., and that in a 1-in. section a silicon content of 1.75 per cent. But they could not do that in practice, of course, so they adopted for the whole casting, a silicon content of 2 per cent., that is the proper silicon content to ensure a good cylinder wall, regardless of what happened to the flange.

A VOICE: Or chill it.

MR. HURST replied that even chilling was not so generally resorted to as all that. However, in all fairness, they should not attribute too wide a scope to the pearlitic process, and that was why he had refrained from dealing with mass effect. Incidentally, there had been no suggestion of it in any of the writings, and that was another point on which the patentees might easily have been more clear without disclosing any essential information.

Crystals and Grains.

Coming to Mr. Lambert's remarks, Mr. Hurst said he disagreed strongly as to the position of the graphite in the crystal boundaries. Mr. Lambert was wrong. It was impossible for the graphite to exist at the crystal boundaries, unless they adopted Mr. Adamson's theories that it existed in the free state in molten iron, which he could assure them it did not. There was no free graphite in molten iron. If Mr. Lambert would reflect that the crystal boundaries were formed long before the graphite was formed, then how was it possible for the latter to exist at the crystal boundaries? He was afraid Mr. Lambert could not produce any evidence of crystal boundaries in cast iron unless in a sample of a slowly-cooled cast iron in which the whole matrix was ferrite. In such a sample the boundaries could be shown by etching. He (Mr. Hurst) suggested that the reason they could not show the crystal boundaries was because they were all hidden by the phosphide eutectic, and that was the constituent which segregated out at the crystal boundaries. The manner in which the last portions of the liquid metal to solidify occupy a position at the crystal boundaries will be found described in any text book. Those last portions were the phosphide eutectic. Therefore, he suggested that Mr. Cook's network structure was the same thing as the crystal structure.

MR. LAMBERT: Are you speaking of "crystals" or "grains"?

MR. HURST: They are one and the same thing.

MR. LAMBERT: I am afraid I cannot agree.

MR. HURST said that Mr. Cook's network structure was all round the crystal boundaries, and the graphite was in the midst of it.

MR. LAMBERT said he had a single grain, about 2¾ in. in dia., which had been examined by Prof. Desch, who had confirmed that it was a single grain, because the crystals in that grain had the same orientation throughout. They must differentiate between crystallites and the grain. He believed the graphite occurred round the grains, and not in the individual crystals that went to build up the grain.

MR. HURST replied that the graphite did not occur round the grain. It was a fundamental property of crystals that they could be broken up into an indefinite number of smaller crystals, all of which had the true habit of the original crystal from which they were broken up. If graphite existed inside that crystal grain, it must, of necessity, exist around the boundaries of those tiny cleavage planes which, when broken up, constituted the smaller crystals.

MR. LAMBERT agreed.

MR. HURST continued that the graphite did not exist round the crystal grain formed during the solidification of the cast iron, but inside the crystal grain. He had taken the trouble to make the point clear because, so far as he knew, it never had been made clear.

Internal Chill Castings.

Replying to Mr. Gardom's question as to why an iron was white at one time and grey at another, Mr. Hurst said that in an article in THE FOUNDRY TRADE JOURNAL for February 1, 1923, page 85, he would find a very plausible explanation. The title of the article was "Internal Chill in Castings." To deal with the matter properly would require another Paper. It all depended on a true conception of the rate of cooling, which was set forth in the article referred to. Whilst it did not deal with the specific point raised by Mr. Gardom, the whole of the underlying theory was outlined.

Finally, Mr. Hurst said they would all be delighted if the Branch-President, when in Germany, could persuade the authorities connected with pearlitic cast iron to demonstrate its value by the very simple test already indicated. The results of such a test would enable them at once to conclude whether pearlitic cast iron was a material worth their consideration or whether it was not.

Vote of Thanks.

MR. SHILLITOE, in proposing a vote of thanks to Mr. Hurst for his Paper, said that the discussion had reminded him of the tests carried out in 1910 by Mr. Neufang, of the Gasmotoren Fabrik Deutz, Cologne, and Diefenthaler, before a patent was thought of. They were working with raw material which was a re-melt of pig-iron and steel made in a small Siemens furnace, and which had an analysis practically the same as that used by Prof. Bauer.

MR. J. ELLIS (Past-President) seconded the vote of thanks, which was cordially accorded.

Institute of British Foundrymen.

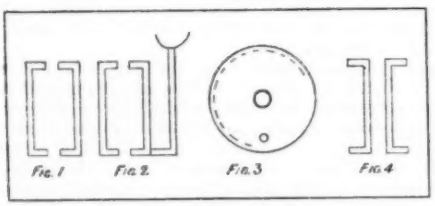
BURNLEY SECTION.

A meeting of the Section was held on October 14 at the Technical College, Burnley, Mr. G. Barnes presiding. It was devoted to an open discussion of foundry problems, two of which were submitted by Mr. J. Hogg and described by him as being very simple in appearance but both the cause of a fair amount of trouble and waste.

The Casting of Rollers.

The first one was the manner of running a roller, say a calender bowl or rubber machine roller. Bowls or rollers for bleaching and printing machine work very often ranged from 3 cwt. to 3 tons in weight, and were generally straight bowls with external or internal bosses at the ends to take the shaft (Fig. 1). They were required to machine up with a very close grain and to be entirely free from holes or blemishes. He had had to deal with these castings many times, and had also seen them made by other foundrymen. Some were very good and clean castings were turned out, but the point he wished to raise for the purpose of discussion was whether they were better cast from the top or from the bottom; he had tried both ways, and the opinion he formed was that it was better to cast from the top. By doing that they had the "live" or hot metal at the top of the casing where it was required, and they were also able to choose the type of runner or gate. Also he believed personally that any moulder could get the job ready for casting quicker.

Of course, he did not say that bowls were not run successfully from the bottom runner (Fig. 2).



Indeed, he knew they were, but after having tried both ways he preferred the top runner, and his practice was to use, not one single runner at one side of the bowl, but broken up. The runners could be very small, and a riser put on if necessary for feeding purposes. The riser could be in the runner box and covered by a stopper till the mould was filled. The runner box could be rammed up off the job and put on the top of the box quite clean. Needless to say, with such small runners the metal would require to be poured hot, which was all to the good. If a ricket vent was taken away from the top of the bowl to allow the gases to escape, it made quite a difference to the speed of the running in of the metal. By experience, and according to the weight of metal required for the job, one could determine the number of runner gates necessary for a sound cast.

He knew this method was used by some moulders, and he wanted the members to discuss the relative merits of top or bottom running on this particular kind of job. He had not mentioned the Cons method of building the moulds, nor the question of the type of metal to use, nor even the spinning gate used by the makers of very heavy rolls. To deal with these themes it would be necessary to write a full-time paper.

MR. HILTON said in his opinion the method of running them at the top with a series of small runners was the most efficient. In the filling of the mould the metal would be kept agitated, when run from the top; this would give any dirt or loose particles a better chance to rise to the top into the riser head, and thus ensure a good chance of having a good clean casting. Again, for the depth of the feeder head, personally he preferred a short one rather than a deep one, as he held that the latter defeats its own object. He had seen rollers similar in shape to the one under discussion, but 3½ tons in weight with but 3 in. of a feeder head, and the end had turned up quite clean, whereas with a deeper head the end had shown shrinkage holes when turned.

Horizontal Casting a Failure.

MR. PELL said that he had not had any personal experience of rollers such as Mr. Hogg described, but he had cast several rollers for sizing machines, and they had to be perfectly clean. At one time they were cast horizontally, and the result was not a success. Now the method adopted was to cast them vertically and allow about 6-in. riser head, running them at the top. He agreed with Mr. Hogg that with this class of work running at the top was the most efficient.

MR. VERNON said he had cast the class of roller mentioned by Mr. Pell horizontally and obtained fairly good results. There was, however, a slightly porous place just below the feeding head. He agreed that running at the top was the most efficient method.

A MEMBER said he worked at a foundry where rollers similar to those described by Mr. Hogg were run from the bottom, and the whole of them were failures. There were spongy places round the top.

Blow Holes in Upper Surfaces.

MR. HOGG said the second problem he had to submit often cropped up in quite small castings as well as in those of large size. What he had in mind were the blow-holes seen on the top of castings which required to be machined. Generally they made their presence known when the top skin of metal was removed by the lathe or planing machine.

He took it that everyone was agreed that the metal must be poured hot to allow the escape of the gases present in the metal. That was an essential point in a problem like this. But even after pouring the metal hot, and with a seemingly good mould, they came up against this trouble. He had known it to occur even with a simple blank pipe, flange or packing gland. He believed it was caused by gas generated in the mould during pouring, and in his opinion one of the chief essentials was to get rid of the gas generated; and also to try to generate as little gas as possible. For example, in a short 3-in. or 4-in. make-up length of pipe (Fig. 4), the bottom part of the mould no doubt would be made of strong sand and coal dust, in order to get a good skin on the surface of the casting. If there was free venting the gases would escape, and no harm would come from the coal dust. But the top part of the mould required rather different treatment. It was flat and simple to mould, but if possible no gas should be generated here.

He had cast a large number of these short pipes and also flanges. The method he adopted was to work with weak dry sand without coal dust. By "dry" sand he meant in this case sand in which the moisture present was only just enough to enable it to stick together. This method was simple, but it had proved of great assistance in getting a good sound top surface, and he hoped every member, even the youngest moulder, would be interested in it. Running played a great part in this question. He was thinking of breast beams for looms, cast face-side up, and also castings for woodworking machinery which were elaborate on one side and flat on the other, which were cast face-side or flat-side down because of this problem.

MR. PELL said he was of the same opinion as Mr. Hogg as to the desirability of the sand for small jobs being kept on the dry side; but for heavier work, for castings 2 or 3 in. thick, the dry state of the top part would not be suitable unless it had been dried in the stove. In the making of breast beams for looms the following method was pretty general in the textile foundry. Fairly good sand was used in the runner area, and a weaker, drier sand was used in the other part of the pattern. A good sow runner cut in the top part had the effect of ensuring a good clean surface.

MR. VERNON said the method of making breast beams with the polished surface up was fairly

general. At the works where he was engaged they adopted a method similar to that described by Mr. Pell.

MR. SMITH said he had cast several large plates that had to be machined all over. Borings were mixed in the sand for the top part. With a good strong top part box it was not necessary to use gaggers to reinforce it. The method used with the top part was that after the face had been sleeked, plumbago blacking was rubbed all over and it was cast green. The castings were a little rough, but they machined well.

A vote of thanks was then accorded to Mr. Hogg.

EAST MIDLANDS BRANCH.

At a meeting held on October 25 at the Loughborough College, Mr. S. H. Russell (Leicester), Branch-President, presiding, said an alteration had been made in the programme, and the secretary, Mr. H. Bunting, arranged for a lecture and demonstration on "Progress in Microscopy for Engineering and Metallurgical Works," by Mr. F. R. Davidson, F.R.M.S., London.

The Microscope in the Foundry.

Mr. Russell, in opening, said Mr. Davidson had developed the use of the microscope along somewhat unorthodox lines.

Mr. Davidson had brought with him a number of instruments, particularly his own attachments, which can be fitted to an ordinary microscope, as well as cameras for photographing at high magnifications.

The lecturer pointed out that everyone connected with the technical side of the industry was alive to the value of the microscope in their research work, and his purpose that evening was to tell them of some comparatively new ideas concerning the manipulation and application of the microscope. Although he dealt with it in a somewhat unorthodox way, that was no reason for condemning his method if he could prove he was able to produce results impossible under any other methods. An attachment gave them a microtelescope, with the result one got a depth of focus or sense of perspective which is outside the possibilities of the ordinary orthodox telescope. This was a very valuable feature, apart from the fact you can use this instrument on near objects as well as on distant objects. Although it has a very wide range of utility its special features in connection with engineering or laboratory work is its use as a cathelometer for the observation of scales of barometers and thermometers, enabling the scales to be read in otherwise inaccessible positions, such as smoke stacks, etc. From this he went on to another attachment—an object glass of shorter focus. With this short focus microtelescope the gap was bridged between the telescope and the microscope. With the microscope only a tiny portion was in focus, but with his attachment one could view in magnifications from 25 to 75 dias. at any distance between 1 ft. and 3 ft. from the stage of the microscope. An extraordinary depth of focus was obtained on a rough surface, and this was of great value for the examination of metal fractures. This application could be made also with a camera fitted instead of the body tube of the microscope.

Mr. Davidson then explained the super-microscope, by which something more than magnification was meant, for magnification was of no value unless accompanied by resolution. In the body of the main-tube was placed another lens tube called a collector, and the effect of this collector behind the primary objective is to bring the image lower down the tube and its actual effect is to shorten the tube length and working distances from 2 ins. for 150 magnifications to 5 to 6 ins. for 75 magnifications were impossible in the ordinary method of application.

After mentioning his indebtedness to Dr. Rogers, of Sheffield, who had investigated his claims, particularly as regards micrography, the speaker said a long extension camera was not needed, and much shorter exposures were used.

Photographs were shown to prove that better results were obtained at magnifications of 2,500 than by 1,000 in the ordinary way.

Discussion.

THE CHAIRMAN said he was desirous of getting information as to the use of the microscope in the foundry. If they had trouble with any material and wished for a chemical analysis, unless there was a local laboratory they had to wait from 5 to 10 days, whereas they wanted to find out what was wrong at once and remedy it and get the castings finished. Could the microscope be of use to ironfounders in detailing these troubles? If so there was a very big scope for its use. The microscope was capable of helping the brassfounder, as he had experience. During the war they had to make gun-metal castings for the Admiralty, and suddenly struck a bad patch, and could not get the elongation though they had the tensile test correct. They sent two test bars to be examined, and within ten days had a series of photographs of these test bars which showed a quantity of small gas holes throughout the structure. They were informed the whole trouble was due to pouring at too high a temperature. Gun-metal alloys have the power of absorbing rather a large amount of gas at high temperatures, and by allowing to cool to a certain temperature much of the gas would be excluded. They adopted the remedy, with the result that the Government sent down to inquire how they managed to get such excellent castings. He was not satisfied, however, that they could use the microscope with advantage for iron founding.

MR. DAVIDSON said they could examine fractures and raw material with varying magnification and at varying distances.

DR. BRAMLEY (Loughborough College) suggested one possible use was to examine for the size of graphite flakes.

MR. J. F. DRIVER (Loughborough College) pointed out that mere saving on raw material might cause them loss greater in other directions, and this was true of the machinery qualities. With automatics their use was restricted by the rate one could get rid of the chippings. He had instances where the output was vastly increased by the selection of the right material, and as in actual practice this amounted to a certain percentage of lead in the mixture the microscope would show whether they were getting the correct type of material.

One of his problems was the examination of raw material by X-rays, and he wanted some plan to examine the fluorescent screen at a safe distance, and he wished to know the maximum possible magnification possible with the super-microscope.

MR. DAVIDSON said they had obtained useful magnification at 5,000, and were experimenting further, the best so far being 7,500. With regard to the other point, it depended on the field required. Magnification of 20 dias. was possible at from 6 to 10 or 12 ft.

Answering questions as to cost the speaker said from £10 to £100, but attachments could be bought for a few pounds to use with one's own microscope.

MR. STEVENS moved a vote of thanks, and MR. EVANS seconding, MR. DAVIDSON, in replying, hoped he had stimulated them to consider possible use of the microscope in their works practice.

WALES AND MONMOUTH BRANCH.

The first meeting of the Session took the form of a social evening, when the members were the guests of the Branch-President, Mr. P. Leonard Gould. The President, Mr. R. O. Patterson, of Newcastle, was the principal guest.

More Foundry Classes.

Ipswich Education Committee has inaugurated at the School of Engineering a course on foundry practice. Mr. A. J. Richman, foundry foreman at Vickers Petters, Limited, has been appointed instructor. An inaugural address was given by Sir Archibald Ross, K.B.E., of R. W. Hawthorn, Leslie & Company, Limited, of Newcastle-on-Tyne. So far 30 pupils have been enrolled.

XUM

Trade Talk.

EXTENSIVE damage has been caused by an outbreak of fire in premises at 11, Fairley Street, Govan, Glasgow, occupied by Thomson & Macintyre, Limited, general pattern makers, etc.

AN ORDER for a cargo vessel of 5,000 tons measurement has been placed by Bar, Crombie & Company, Limited, Glasgow, with the Greenock Dockyard Company, Limited.

GUEST, KEEN & NETTLEFOLDS, LIMITED, have appointed Mr. W. Hill, with offices at 12, Westgate Road, Newcastle-on-Tyne, as their representative in that area in succession to Mr. J. T. T. Brunskill, who has retired after 52 years' service.

THE BIRKENHEAD FERRIES COMMITTEE have recommended the acceptance of the tender of Cammell, Laird & Company, Limited, for the building of two new passenger ferry boats and two goods boats for £220,000.

AN APPLICATION by Walker, Hunter & Company, Limited, Port Downie Iron Works, Falkirk, for permission to erect a new roof on steel columns above their existing moulding, dressing and fitting shops, has been sanctioned in the Falkirk Courts.

IN VIEW of the decision of the Hull City Council not to purchase German-made tram rails, the Hull Corporation Tramways Committee has decided to place the contract again with Bolckow, Vaughan & Company, of Middlesbrough, whose tender was £12,291.

AT THE LAST MEETING of the Staffordshire Iron and Steel Institute, at the Education Offices, Dudley, the first presentation of the Institute Research Medal was made to Mr. Francis S. Dodd, of Walsall, for his research work and paper on "Grain Growth in Mild Steel." This paper is to be read to the members at Dudley on November 21.

INTIMATION has been made to Messrs. J. C. Bishop and O. Coyle, joint secretaries of the Board of Conciliation for the Pig-iron Trade of Scotland, to the effect that the average net selling price for July, August and September is £4 16s. 8d. per ton. That means that there will be a reduction in the wages of the workmen of 3 per cent. on basis rates.

W. E. BURNAND & COMPANY, electric power engineers and wholesale dealers in electrical supplies, Chippinghouse Works, Lowfields, Sheffield, have acquired the premises formerly known as Argus Works, Shoreham Street, Sheffield, to which they will be removing in a few months' time after necessary structural alterations have been carried out. These works are more central and much larger than the company's present establishment.

NAPIER & MILLER, LIMITED, Old Kilpatrick, have received from the Eastern Steamship Company, Limited, of Fort-Colborne, Ontario, an order for a third single-screw steamer, similar to the two which they booked in August, and which are now under construction. The vessel will be of 1,750 tons gross and 2,500 tons deadweight, and will have triple-expansion engines by David Rowan & Company, Limited, Glasgow.

THE A.C.E.C., 56, Victoria Street, London, S.W.1, inform us that the Belgian Posts and Telegraph Department have placed a contract with the Ateliers de Constructions Electriques de Charleroi for the supply of paper-insulated, air space, lead-covered, multiple-core telephone cable, and for paper-insulated, air space, lead-covered and armoured multiple-core telephone cable, the contract price being approximately 1,431,000 fcs. (£15,256).

A STRIKE IS threatened by the twelve Unions connected with the light castings industry. An application lodged with the employers some time ago asked that an increase of 15s. per week be granted to the men to compensate for a reduction of a similar amount made in 1922. The employers refused this application on the ground that an increase in wages would necessitate an increase in prices and a consequent lessening of the demand for goods manufactured in the industry. The men have voted in favour of striking unless their demands are conceded.

CAMLOY is the registered trade mark for a series of nickel chrome iron alloys manufactured by L. Cameron & Son, Limited, Boston Works, Mary Street, Sheffield. These alloys are obtainable with a large range of physical properties, and are distinguished by their stain and corrosion resisting properties and their ease in working hot or cold. Camloy NC 33 is a particularly useful alloy which has found a large application. Its physical test is: Y. pt., 25 tons per sq. in.; max. stress, 43-45 tons; elong., 38-40; Brinell, 160-180, and this is not materially altered by heating, cooling, quenching or annealing. It will draw into wire, and may be readily used for spinning and deep pressing. The colour is much whiter than stainless steel and iron, and the metal finishes with a silvery lustre. This material is being used by Wm. Gallimore & Sons, Limited, Arundel Works, Sheffield, and is known to the trade as "Gallimore's Stainless."

Gazette.

MR. W. R. WILLIAMS, 23, Wilson Street, London, steel and tool merchant, has been adjudicated a bankrupt.

MESSRS. D. ALLAN and J. ALLAN, engineers and electric welders, 12, Yorke Street, Wrexham, Denbigh, trading under the style of D. & J. Allan, have dissolved partnership.

THE PARTNERSHIP HERETOFORE existing between Messrs. S. V. Mathews and E. H. Morris, trading as the Cestrian Brass Foundry Company, Hamilton Place, Chester, has been dissolved.

MESSRS. T. VARTY and F. L. VARTY, trading as N. Varty & Sons, Mill Road, Royston, Herts, brass and iron founders and mechanical engineers, are paying a first and final dividend of 13s. 2d. in the £. In the separate estate of Mr. F. L. Varty a first and final dividend of 4d. in the £ is being paid.

THE FIRST MEETING of the creditors of the Birchfield Foundry Company, Limited, Chain Walk, Birchfield, Birmingham, was held recently at the offices of the Official Receiver. The winding-up order was made on September 18 on a petition presented on September 2 by three creditors whose claims aggregate £2,132. The statement of affairs deposed to by the managing director of the company was lodged on October 3. The statement showed gross liabilities amounting to £4,978, of which £3,459 is estimated by the company's officers to rank for dividend. The deficiency is estimated to rank at £3,459, plus a deficiency created by capital issued and allotted of 225 ordinary shares of £1 and 1,087 preference shares of £1 each, all fully paid, giving a total deficiency of £4,771.

Personal.

MR. H. WORSDALL is leaving the Igranic Electric Company, Limited, Bedford, to take up an appointment as sales engineer with the Riley Stoker Company, Limited, of Westminster, S.W.

MR. M. M. GILLESPIE, of Gillespie & Beales, Amberley House, Norfolk Street, Strand, London, W.C., who has for many years represented the interests of Browett, Lindley & Company, Limited, Patricroft, Manchester, has been elected a director of the company. He will attend to their business as heretofore at the present address.

MR. T. G. CLARSON, hitherto with Metro-Vick Supplies, Limited, Central Buildings, Westminster, London, S.W., has been appointed district sales manager for the Northern Area for the Jackson Electric Company, Limited, 143, Sloane Street, London, S.W.1.

SIR SEYMOUR B. TRITTON, of Rendel, Palmer & Tritton, civil and consulting engineers, Westminster, is shortly making an extensive tour of India, Burma and Assam, at the request of the Chief Commissioner of Railways in India, to report upon questions relating to the standardisation of locomotives and rolling stock. He will be accompanied by his son, Mr. J. S. Tritton.

Wills.

VICARS, T., of T. & T. Vicars, engineers, Earlestown £70,926

GILKES, GILBERT, at one time connected with Gilbert Gilkes & Company, Limited, of Canal Iron Works, Kendal £38,444

MADDOCKS, JOHN, a director of the Firth-Brearley Stainless Steel Syndicate, Limited, Sheffield £63,933

RICHARDS, E. J. WINDSOR, of 115, Worple Road, Wimbledon, S.W., consulting engineer, formerly associated with the South Wales iron trade £15,785

Obituary.

MR. S. WHITELEY, the founder of the firm of S. Whiteley & Sons, Limited, Moor End Tin Works, Cleckheaton, Yorks., died recently at the age of 61.

MR. J. M. MCGRATH, of Alwyn House, Finchley Lane, Hendon,, died recently, aged 74. He had for many years been the principal London representative of W. & T. Avery, Limited.

MR. W. H. UNDERHILL died last week at his residence, 7, Parkdale, Wolverhampton. Mr. Underhill, who was 68 years of age, was at one time closely associated with the iron trade of the district.

MR. A. T. COATES, of Benwell, Darlington, died recently. He had for some years occupied the position of managing-director of the Whessoe Foundry & Engineering Company, Limited. The deceased was in his 54th year, and had been associated with the company since 1891. He succeeded his father, the late Mr. Thos. Coates, in the managing-directorship on the latter's death in 1913, and the company took its present title in 1920 upon reconstruction.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.

THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The turmoil of the political upheaval having subsided, a more settled condition is now apparent in the pig-iron industry, and at the current week's Cleveland market a much more confident feeling of an early resumption of activity in the trade was expressed on all sides, and values were higher. As a rule, there is but little forward business put through until well into November, and the fact that it is being done now would seem to show not only a greater measure of confidence in the outlook, but also that users are convinced that they are not likely to go far wrong at the present level of prices. Indeed, indications point rather to a further hardening of values than otherwise. One firm of makers is stated to have sold the whole of its output up to the end of the year, and this is significant in view of the comparatively small aggregate production and the low stocks. In this week's market No. 3 G.M.B. was firmly held at 81s. per ton, with No. 1 86s., No. 4 foundry 80s., and No. 4 forge 79s. per ton.

Some improvement also may be already noted in the hematite market, based on a better inquiry on Continental account. The volume of inquiry, though not amounting to a great deal in the matter of tonnage, is at least encouraging, and has been sufficient to stiffen makers' ideas. At present 88s. per ton for East Coast mixed numbers is a minimum figure, and one or two makers are inclined to press for 6d. per ton more. No 1 is quoted at 88s. 6d. per ton. Similar conditions apply equally in the North-West Coast area, where prices, however, have undergone no change, Bessemer mixed numbers being marked at 100s. per ton delivered at Glasgow, 102s. 6d. per ton delivered at Sheffield, and 106s. per ton delivered at Birmingham.

LANCASHIRE.—The demand for foundry pig in this area continues in restricted volume, and in Manchester sellers of the Midland irons quote the same prices as those previously current, but there is very little business, and, as a matter of fact, neither consumers nor producers are anxious to do much until the outlook is more settled. The price of No. 3 Derbyshire seems to be settling down at 80s. f.o.t.

Metals.

Copper.—The tendency of standard values in this market of late has inclined, if anything, to increased firmness, stimulated apparently by the recent change in the political situation, and by the anticipation of similar favourable effects of the American Presidential election. European consumption of the metal is on a fair average, and is perhaps capable of a further extension under the improving economic situation, but the future course of the market hinges on American trade possibilities after the election just concluded. Current quotations:—*Cash*: Thursday, £63s. 7d, 6d.; Friday, £63 10s.; Monday, £63 17s. 6d.; Tuesday, £63 17s. 6d.; Wednesday, £63 15s.

Three Months: Thursday, £64 10s.; Friday, £64 12s. 6d.; Monday, £65; Tuesday, £65; Wednesday, £64 17s. 6d.

Tin.—Movements in the market for standard tin during the current week point to a further stiffening of values, based on the anticipated favourable statistics for the past month, and although, of course, largely dependent on speculative interest, the outlook is certainly regarded with more confidence than has been usually forthcoming of late. Fairly liberal purchases have been made in the East. Current quotations:—*Cash*: Thursday, £257 15s.; Friday, £258 15s.; Monday, £259 5s.; Tuesday, £256 2s. 6d.; Wednesday, £257 15s.

Three Months: Thursday, £259 10s.; Friday, £260 12s. 6d.; Monday, £261; Tuesday, £258 2s. 6d.; Wednesday, £260 10s.

Spelter.—Business passing in this metal at the moment is by no means heavy, but supplies have been on a restricted scale. Continental producers are not offering much, but there is no desire to force rates up, as this presumably would lead to developments on the American side. The market would derive some benefit from any general movement in the non-ferrous group later on. Current quotations:—*Ordinary*: Thursday, £34 6s. 3d.; Friday, £34 6s. 3d.; Monday, £34 7s. 6d.; Tuesday, £34 8s. 9d.; Wednesday, £34 11s. 3d.

Lead.—Anticipations of a heavier demand for soft foreign pig and a stiffening in price have been more than realised, as values have advanced more rapidly than expected as the result of speculation. Consumers are now disposed to cover only immediate needs and wait for some relaxation in price.

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